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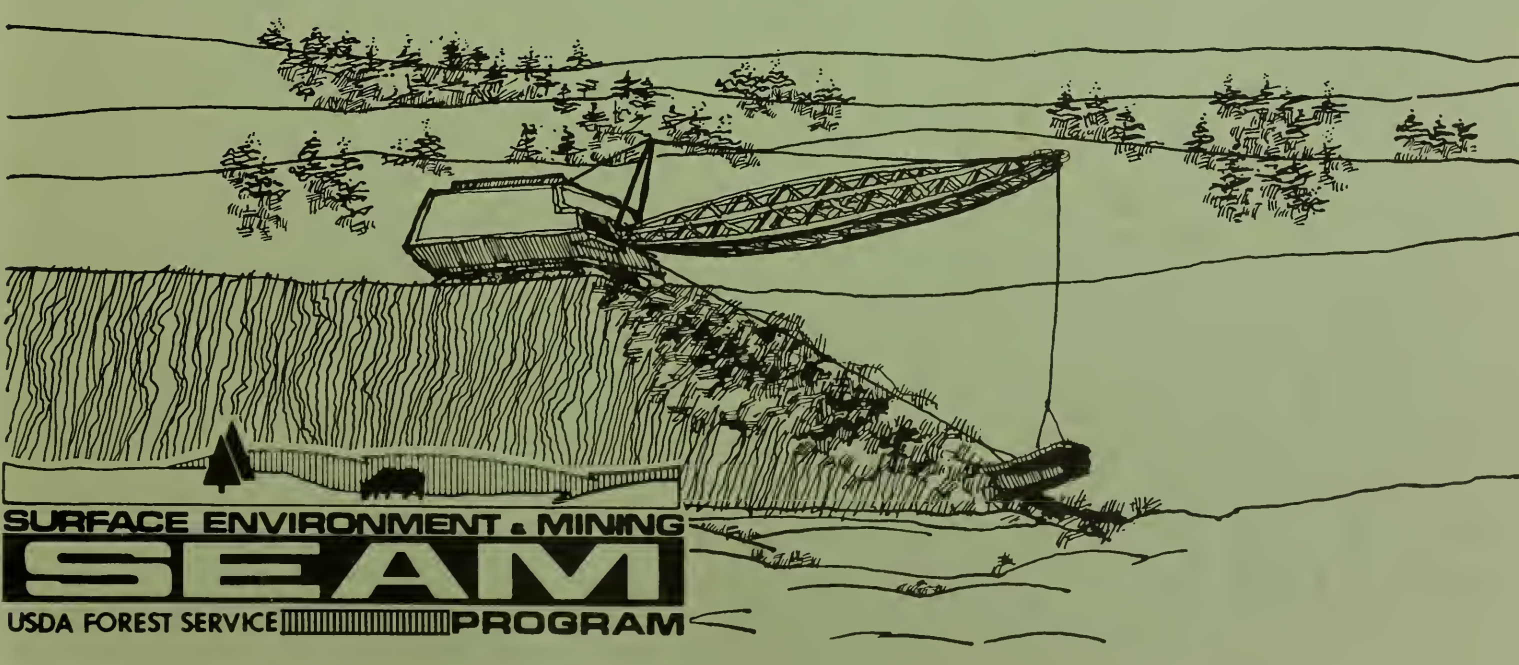

SURFACE ENVIRONMENT & MINING
SEAM
USDA FOREST SERVICE PROGRAM

CLAIM

Computerized Reclamation Planning System for Northern Great Plains Surface Coal Mines

PROGRAMMER'S MANUAL

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Preface

This material constitutes the programmer's manual for the CLAIM Computerized Reclamation Planning System. The CLAIM system was designed for implementation on a Hewlett Packard 9640A Multi-Programming System which uses the 21MX series computer operating under the RTE-III system. The HP 21MX computer operates with a 16-bit word length; with integer variables occupying one word (16 bits), and real variables occupying double words (32 bits). Graphics routines may be operated on both the Tektronix 4014-1 or the Tektronix 4006 CRT (as well as other Tektronix models) under the PLOT-10 terminal control system. The nongraphics part of the CLAIM system may also be operated on any standard Teletype unit without graphics capability. The CLAIM system is written in the FORTRAN IV programming language, and requires a minimum partition size of 17K words on the HP computer. (The reader is referred to SEAMPLAN manuals (Mooney et al.]979) for a complete description of the minicomputer system.)

The CLAIM system is a user-oriented reclamation tool that evaluates user-input information to develop a reclamation plan for a Northern Great Plain's surface mining area. The reclamation plan consists of three segments--an environmental feasibility ranking (FEASI), a techniques and economics listing (TECON), and an optimum land use ranking (OPUSE) for 5 land use options. Required user input is divided into ten categories, and is fully described

in the CLAIM data book and user's manual (Scott 1980, 1980a). Spoils grading, for either dragline or truck and shovel mines, is also simulated in this model. CLAIM also may be operated through SEAMPLAN (Mooney et. al 1979b) for the steady state (mine run stage) of a single seam dragline mine. Before studying this programmer's manual, the reader should review the CLAIM user's manual and data book, so that he understands the logic and theory behind the program's organization.

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Sections I - VIII of the programmer's manual contain notes on the operation and programming of CLAIM, while sections IX and X contain the appendices and the complete program listing.

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SECTION I: Program Structure

A. Introduction

The CLAIM system is comprised of six logical segments:

1) System Information
2) General Mine Description
3) Environmental Data
4) Data Storage
5) Data Review
6) Data Analysis

Associated with the above segments, described fully in Sections II-VII, are several options (see Figure 1). These options are scheduled through a main executive (See Heading C below) and a series of sub-executives (See Figure 2), giving the user almost complete control over each stage of the program's progress.

All CLAIM programs are tied together by a common block (see Heading C below, and Appendix A) which contains all information needed by the CLAIM system. Although every effort has been made to eliminate system-dependent code from the CLAIM programs, those system routines associated with file reads/writes and spooled output, as well as the routines needed by the PLOT-10 terminal control system have, by necessity, been included in the program code. Also, the executive, CLAIM, requires system dependent code for logical unit assignments and disk track allocation. All system routines CLAIM are listed in Appendix D, and described fully in SEAMPLAN (Mooney, et al. 1979, 1979a, 1979b) and the Hewlett-Packard RTE handbook (Anonymous 1978).

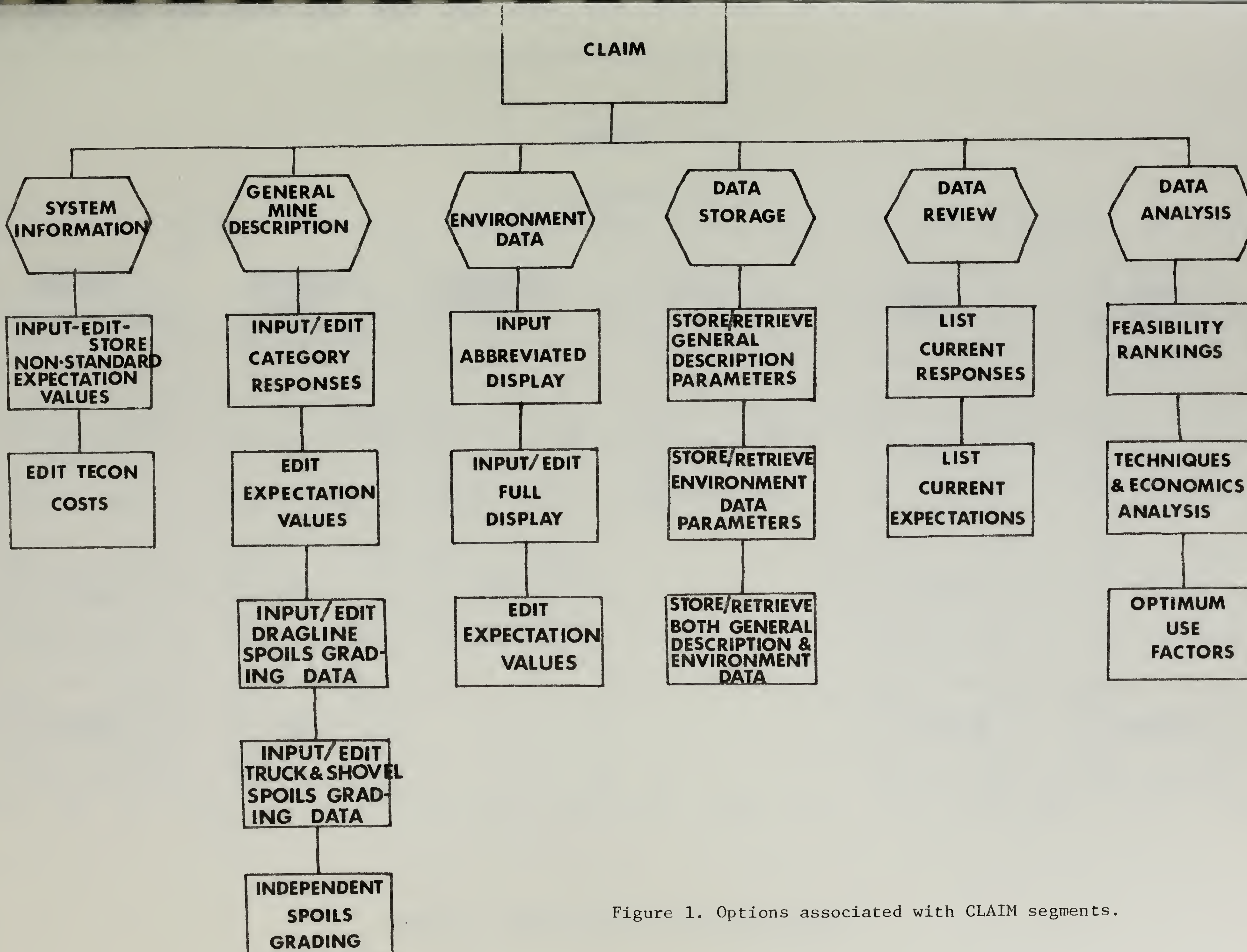

Figure 1. Options associated with CLAIM segments.

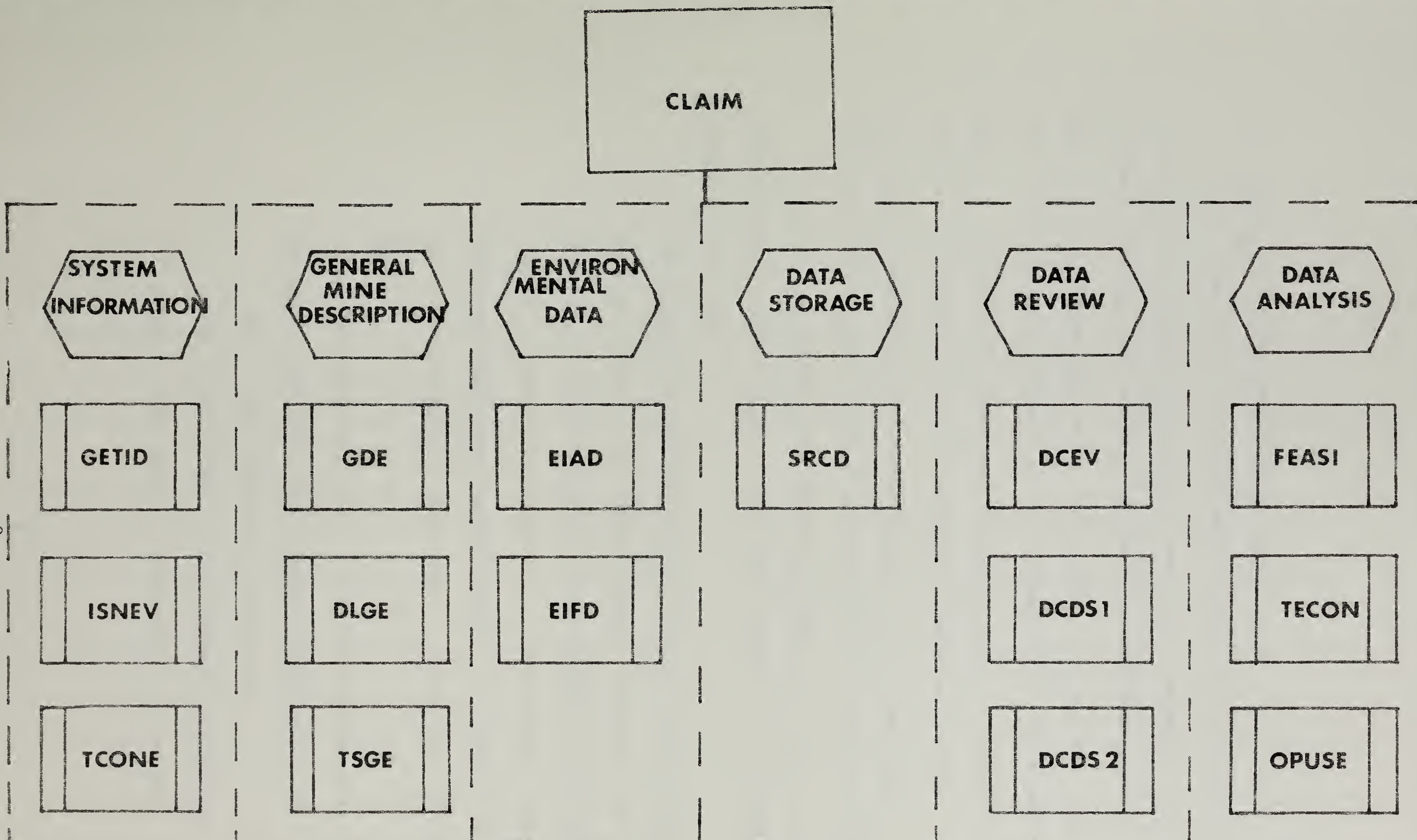

Figure 2. CLAIM Executive and Subexecutives.

B. Communication Between Program Segments

Memory limitations on the HP mini-computer system prevent loading the entire CLAIM system into core at one time. Therefore, the CLAIM system is divided into several program segments which reside on the disk and are swapped into memory as needed. Information required by the various segments is declared in a common block (see Appendix A) which, in addition to being memory resident with the currently active program, is stored in a set of contigious tracks on the disk. By reading from and writing to these tracks, each program segment is executed as if it were called directly by the scheduling program.

In order to eliminate the system dependent code required by the swap procedure from the body of the CLAIM programs, the following method was employed:

1. The calling program (the Father) issues a call to the desired subroutine in normal fashion. However, the "real" subroutine is not loaded into core memory with the Father--rather, a "dummy" subroutine by the same name is scheduled. The dummy subroutine has one purpose: to pass the ID segment of the program to be swapped (the Son) to subroutine SWAPC.

2. Subroutine SWAPC executes the system dependent code needed for the swap. The sequence or operation is:

   Step 1: Call IDSEG to load the SON

   Step 2: Call EXEC to write common to the disk

   Step 3: Call EXEC to swap control to the SON

Step 4: Call EXEC to read the (updated) common block from the disk

Step 5: Call IDSEG to release the SON

3. The SON, scheduled when step 3 above is executed, does the following:

   1. Calls RMPAR to retrieve the parameters describing the location of the common block

   2. Reads the common block from the disk

   3. Calls the "real" subroutine called by the Father

   4. Writes common back to the disk

   Control is passed back to SWAPC - step 4

All system dependent code required by the SWAP procedure can be eliminated, then, by disregarding the unneeded dummy subroutine, subroutine SWAPC, and the SON program (see Figure 3). Those CLAIM program segments using the swap procedure are listed in Appendix C.

C. System Executive: CLAIM

Program CLAIM is the main executive for the CLAIM system and is scheduled directly by the user. Its function is to allow the user to selectively schedule the various options provided by the CLAIM system. These options, as presented to the user, are shown in Figure 4. The subroutines associated with these options are described fully in Sections II - VII, and are mentioned here only to indicate the flow of the program. The sequence of operations is as follows:

1. Get the logical unit of the terminal

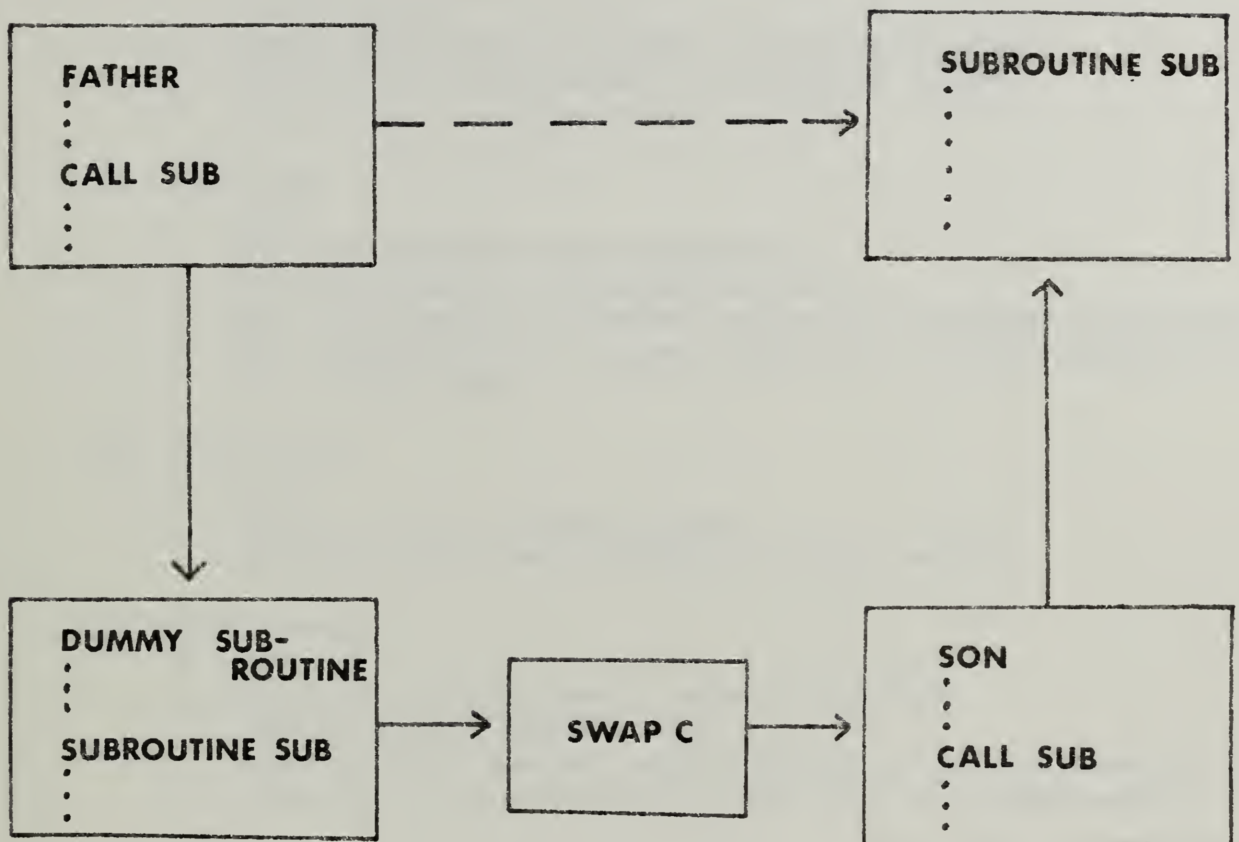

Figure 3. Swap Structure

0. Terminate

I. Data Input
   Ø. Exit
   1. Manual input of the general mine description
   2. File input of the general mine description
   3. Manual input of environmental data
   4. File input of environmental data
   5. File input of both the general mine description and environmental data
   6. Manual input of non-standard expectation values
   7. File input of non-standard expectation values
   8. Input title to appear on all output

II. Data Edit
   Ø. Exit
   1. Edit the general mine description
   2. Edit responses to environmental data
   3. Edit expectation of success values for the general mine description
   4. Edit expectation of success values for the environmental data
   5. Edit TECON costs

III. Data Review
   Ø. Exit
   1. Display current CLAIM data set
   2. Display current expectation of success values

IV. Data Storage
   Ø. Exit
   1. Store the current general mine description
   2. Store the environmental data
   3. Store both the general mine description and environmental data
   4. Store current non-standard expectation of success values

V. Data Analys
   Ø. Exit
   1. Environmental feasibility rankings
   2. Techniques and economics analysis
   3. Optimum use factors

VI. Spoils Grading
   Ø. Exit
   2. Dragline opening cut option
   2. Dragline mine run option
   3. Dragline final cut option
   4. Truck and shovel opening cut option
   5. Truck and shovel mine run option
   6. Truck and shovel final cut option

Figure 4. User option outline

After all elements in the common block are set to zero to ensure proper initialization of all variables, CLAIM calls the system routine RMPAR to retrieve the logical unit number of the user's terminal. RMPAR returns a five word buffer (IARRY), the first word of which, in this instance, contains the logical unit number of the user's terminal. To avoid repeated references to the unwieldy and non-descriptive variable IARRY(1), this element has been equivalenced to the variable LUT during declarations. The values or the other four elements returned in the IARRY buffer are not required by the CLAIM system and are re-initialized as needed.*

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*NOTE: Several CLAIM subroutines are used by program RCLAM, the SEAMPLAN level three reclamation analysis executive. IARRY (2) is used as a pointer to indicate which of the two programs is the calling program. A value of IARRY (2) = 3 means that RCLAM is the scheduling executive, and only those items applicable to the mine run-option of a dragline mine are valid. CLAIM sets IARRY (2) to zero to indicate that all options are permissable. IARRY (3) is used as the logical unit number of the CALCOMP Plotter, and is assigned a value when used. The last two cells of the IARRY buffer are not used.

D. SYSTEM EXECUTIVE: CLAIM

Program CLAIM is the executive for the CLAIM system. Its function is to allow the user to selectively schedule the various options provided by the CLAIM system. The subroutines associated with these options are described fully in Sections II-VII, and are mentioned here only to indicate the flow of the program. The sequence of operations is as follows:

1. Get the logical unit of the terminal

A call to the system routine RMPAR returns a five word buffer (IARRY), the first word of which contains the logical unit of the user's terminal (LUT). IARRY(2) is set to zero to indicate that the CLAIM system is not scheduled by SEAMPLAN(2).

2. Allocate tracks for the common block

A call to the system routine EXEC allocates tracks for the common block. Information returned by the EXEC call is:

(i) The starting track number (ISTRK)

(ii) The disc LU number containing the tracks (IDISC)

(iii) The number of sectors per track (ISECT)

The variable ISECT is set to zero to indicate the starting sector number. (Reference to the RTE Reference Manual (Anonymous 1978) is suggested for a description of disk organization.)

3. Determine graphics capability

This is determined by asking the user a question. The logical variable LER is set to .TRUE. if the user indicates graphics capability. (On the Montana State University HP system,

logical units 9 and 11 currently have graphics capability.)

4. Initialize the common block

CLAIM schedules subroutine GETID (see Section II, Heading B) to input the system data. GETID returns a value of EXIT = -1 if the initialization fails (usually because the storage cartridge containing the initialization files is not mounted) and CLAIM terminates. (CLAIM files reside on CR 15 on the MSU HP system.)

5. Present CLAIM options

A menu is presented displaying the six user options (Figure 4): Data Input, Data Edit, Data Review, Data Storage, Data Analysis, and Spoils Grading. The local variable IPTR is assigned a value corresponding to the user's selection, and the following occurs:

IPTR = 1 (Data Input)

The Data Input options are presented, and the local variable "IPTR1" set to the user's selection. CLAIM assigns the following values at this point:

MODE = 1 (Input Mode)

EXIT = (Category Jump Number)

LEXIT = 1 (Heading Jump Number)

IOPTN = 1 (Utility Pointer)

Another pointer, IPNTR, is set according to the value of IPTR1. The following table lists the subroutine scheduled and the IPNTR value assigned for each IPTR1 value:

TABLE 1. User input option with corresponding IPNTR values and subroutine scheduled.

IPTR1 VALUE	OPTION	IPNTR value	SUBROUTINE SCHEDULED	SECTION DISCUSSED
1	Manual Input of the general description	IPNTR = 1	IGD	III
2	File input of the general description	IPNTR = 1	SRCD	VI
3	Manual input of the environmental data	IPNTR = 2	EIAD or EIFD	IV
4	File input of the environmental data	IPNTR = 2	SRCD	VI
5	File input of the entire CLAIM data set	IPNTR = 3	SRCD	VI
6	Manual Input of non-standard expectation values	IPNTR = 1	ISNEV	II
7	File input of non-standard expectation values	IPNTR = 3	ISNEV	II

Upon return from the above subroutines, CLAIM schedules TFCD (II-E) for IPTR1 values of 1 through 5. TFCD returns on "IOPTN" value of zero if the data are complete, and an "IOPTN" value of 1 or 2 if the data are incomplete. IOPTN = 1 means that the user wishes to complete data entries, IOPTN = 2 means that the user does not want to complete date entries. CLAIM branches to the appropriate block of code according to the IOPTN value.

A value of IPTR1 = 8 is also possible, but no subroutines are scheduled. CLAIM allows the user to input a title (TTL) to appear on all output.

IPTR1 = 0 indicates an exit from the Data Input Option.

IPTR = 2 (Data Edit)

The Data Edit options are presented, and the local variable IPTR1 is set to the user's selection as shown in Table 2.

TABLE 2. Data Edit options associated with each IPTR1 value, and the corresponding subroutine called, and "MODE" setting for each option.

IPTR1	OPTION	MODE VALUE	SUBROUTINE SCHEDULED	SECTION DISCUSSED
1	Edit the general description	MODE = 2	IGD	III
2	Edit the environmental data	MODE = 2	EIFD	IV
IPTR1	OPTION	MODE VALUE	SUBROUTINE SCHEDULED	SECTION DISCUSSED
3	Edit expectations for general description	MODE = 3	IGD	III
4	Edit expectations for	MODE = 3	EIFD	IV
5	Edit TECON costs	---	TCONE	II

IPTR1 = 0 indicates an exit from the Data Edit option.

IPTR = 3 (Data Review)

The local variable IPTR1 is set to 1 for environmental data display, and to 2 for expectation value display. For IPTR1 = 1, the user inputs the list device, (either the terminal or the line printer), and subroutines DCDS1 and DCDS2 are scheduled. When the list device is the terminal, DCDS1 returns and EXIT value of minus one, if the user elects to exit from the environmental data display option, and DCDS2 is not scheduled. For IPTRI = 2, subroutine DCEV is scheduled.

IPTR1 = 0 indicates an exit from the Data Review option.

IPTR = 4 (Data Storage)

The Data Storage options are presented, and the local variable IPTR1 is set to the user's selection. Subroutine SRCE is scheduled for IPTR1 values of 1, 2, or 3. IPNTR is set to 1 for general description storage, 2 for environmental data storage, and 3 for storage of the entire CLAIM data set. For IPTR1 = 4, the pointer IPNTR is set to 2 and subroutine ISNEV scheduled to store the current expectation values. A value of zero for IPTR1 indicates an exit from the Data Storage Option.

IPTR = 5 (Data Analysis)

Subroutine TFCD is called to test for a complete data set. The "IOPIN" value returned by TFCD is tested as described under "Data Input". If non-zero, CLAIM branches out, otherwise, the "Data Analysis" options are presented. The following table shows the subroutines scheduled, and the IPNTR values declared:

TABLE 3. Data analysis subroutines, with corresponding IPNTR values.

IPTR1	OPTION	IPNTR VALUE	SUBROUTINE SCHEDULED	SECTION DISCUSSED
1	Environmental Feasibility Ranking	1	FEASI	VII
2	Techniques and Economics Analysis	1	TECON	VII
3	Optimum Use Factors	3	FEASI, TECON, OPUSE	VII

IPTR1 = 0 indicates an exit from the Data Analysis option.

IPTR = 6 Grade Spoils

This option is presented to allow the user to calculate spoils grading volumes and costs, without a specific land use option in mind. MODE is set to 4 for this option, and all grading restrictions, other than those required by the geometry or the situation, are removed. The common variables reserved for the cropland alternative are used for this option. First, the local variables IMINE and ICUT are set to type of mine (RGENDE(1)) and

stage in mining sequence (RGENDE(2)), respectively. Next, the user selects from the "Grade Spoils" menu, and RGENDE(1) and (2) are set accordingly. GDE is then scheduled. When the user wishes to terminate this option, all grading parameters are set to zero to ensure that subsequent data analyzed by the CLAIM system meet all reclamation restrictions. RGENDE(1) and (2) are reassigned their original values (IMINE, ICUT), and CLAIM branches back to the primary menu.

6. Release tracks

A call to the system routine EXEC is made to release the tracks used by the CLAIM system, and CLAIM terminates.

SECTION II - SYSTEM INFORMATION

A. Introduction

By "system information", we are referring to those data that do not require user input - specifically, the text associated with the category responses, the text associated with the master list of available techniques, the costs associated with the techniques, and the standard expectation values. The expectation values and the costs associated with the techniques are the only system information data that the user may edit during program execution - all other items mentioned must be edited externally. All system information subroutines are summarized in Figure 5.

System information data are contained in the four files:

EXPTNS - Standard Expectation Values

TEXTEC - Text for the environmental categories

MLT - The text for the master list of available techniques

CCFTS - The costs for the TECON analysis

System information data are entered by subroutine GETID.

B. Common Block Initialization - GETID

Subroutine GETID is called by CLAIM to initialize the common block. GETID uses the system routine SPOLU for all file reads. The files read, and the common variables initialized by GETID are shown below.

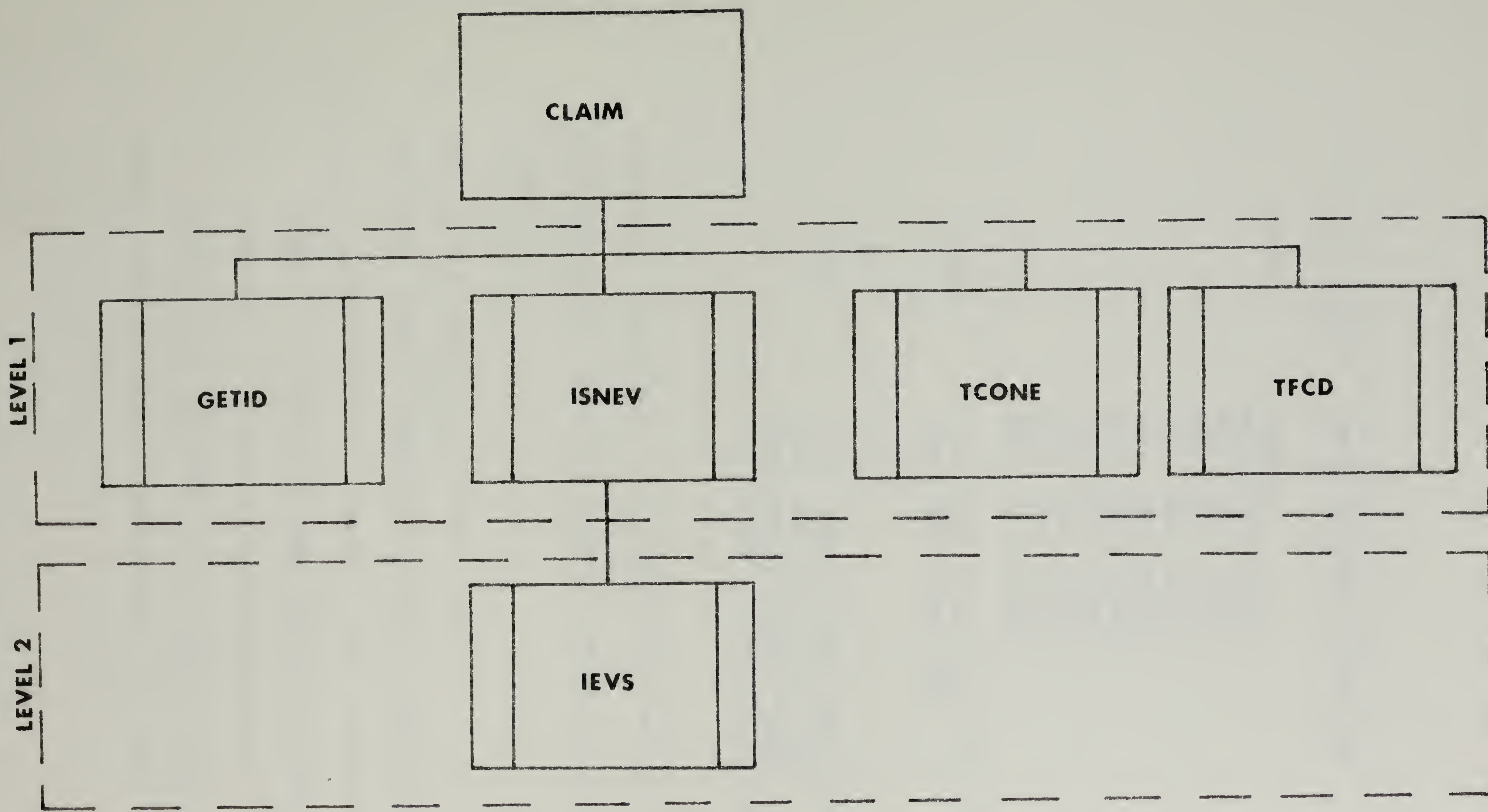


Figure 5. System Information Subroutines.

FILE READ	COMMON VARIABLE INITIALIZED
EXPTNS	NSECTS NGEN, IGEN, GENDES NCLI, ICLI, CLIMAT NTOP, ITOP, TOPSOI NSUB, ISUB, SUBSOI NOVR, IOVR, OVRBDN NSUR, ISUR, SURHYD NGRW, IGRW, GRWHYD NVEG, IVEC, VEGETA NANM, IANM, ANIMAL NSOC, ISOC, SOCECN
TEXTEC	GDES, CLMA, TPSL SBSL, OVBD, SWHY, GWHY, VGTA, ANMA, SCEC
MLT	RCLTEC
CCFTS	CAAHM, CABAH, CABFN, CABEP, CABHM CABS, CAC, CACP, CADF, CADH, CADS, CAEAF, CAHSAF, CAHSTS, CAIP CAR3FC, CASF, CASNC, PFSTSP, PFAC

A returned (from SPOLU) value of LUF less than zero indicates a file-read error. When this occurs, a message is printed, and EXIT is set to -1.

C. User-defined expectation values - ISNEV

Subroutine ISNEV is scheduled by CLAIM to imput, store, or retrieve non-standard expectation values. ISNEV is directed by IPNTR to:

IPNTR = 1 → Manually input expectation values

IPNTR = 2 → Store the current expectation values

IPNTR = 3 → Retrieve a set of expectation values

All files created by ISNEV are identified by the characters "#$" in the

first word of the file's ID segment. The last two words are furnished by the user.

IPNTR = 1

The user inputs the category number (ICN), the heading number (IHN), and the land use option (LUO) of the expectation values he wishes to input. If these values are valid, subroutine IEVS (see below) is scheduled to input the expectation values. A returned value of IEX = -1 means that the user wants to exit from the subheading, and ISNEV branches to the ICN input. A special value of ICN = -1 is used to indicate that the user wants to input expectation values for the "other" category, and ISNEV loops through all categories and headings for LUO = 6, until the user indicates an exit, or all data have been entered. ISNEV terminates when the user imputs an ICN value of zero.

IPNTR = 2 or IPNTR = 3

The system routine SPOLU is called to open FILID (the user input file name). The expectation values are written to the user's file (IPNTR = 2) or read from the user's file (IPNTR = 3) using the expectations values' location in the common block (words 3733-4938). Should the user input an invalid file name, he is given an error mssage and asked to re-input the file name. SPOLU closes the file after the read or write is completed.

1. Subroutine IEVS

IEVS is accessed by ISNEV (above) to read the user's expectation value. Arguments passed to IEVS are:

ICN = the current category number

IHN = the current heading number

IEVS returns the parameter "IEX", which contains the expectation value (or -1 if the user has indicated an exit). IEVS uses the array ICOM in place of the CLAIM common block. The arrays ISW1 (starting word of expectation array), ISW2 (starting word of array containing the number of subheadings per heading), and ISW3 (starting word of array containing the number of headings per category) are used to determine the location of the desired input in the common block. The expectation value (IEX) is then input. If -1, IEVS returns, otherwise, IEX is tested for validity. If valid, the value is put in the ICOM array, and IEVS returns. Otherwise, an error message is given, and the expectation value re-input.

D. Edit TECON costs - TCONE

Subroutine TCONE is accessed by CLAIM to allow edits to the current costs used by the techniques and economics analysis. The user is given the current cost list, and enters his changes. The current cost list is obtained, via SPOLU, from the file CCFTS. The user has the option of making those changes permanent by requesting it, and entering the security code "RECMOD." The file is overwritten for a permanent change; otherwise it is simply closed.

E. Complete data test - TFCD

Subroutine TFDC is accessed by CLAIM to report the current status of the data set. TFCD is directed by IPTNR to:

IPNTR = 1: Test General Description values only

IPNTR = 2: Test Environmental Data only

IPNTR = 3: Test the entire CLAIM data set

The method is to find the first zero value in the category response set. EXIT is set to the category number, and LEXIT to the heading number. If the data are complete, IOPTN is set to zero. For IPNTR = 1 or 3, grading parameters currently entered are displayed and TFCD returns. If the data are incomplete, the user is informed of the next category and heading requiring input. The user may complete data entries (IOPTN is set to 1), or not (IOPTN = 2) and TFCD returns.

SECTION III: GENERAL MINE DESCRIPTION

A. INTRODUCTION

The GENERAL MINE DESCRIPTION segment schedules inputs and edits to those data described in the CLAIM User's Data Book under Category I, and computes grading costs for the mine site. Various aids are provided for the user during his definition of the post-mining topography. For the dragline mine, graphs of final slopes vs. volumes and costs are offered. A set of default slope/percent pairs is also available for direct implementation; or, if the user elects to input his own slope/ percent pairs, recommendations for appropriate percent mixtures for various slope intervals are provided. The truck and shovel mine also offers default slope sets for each alternative; however, these slopes may not always "fit" because of geometrical considerations. Therefore, immediate edits to the initial data are offered when needed. Suggestions for adjustments to the initial data are provided whenever a desired final slope value is less than the minimum possible. In addition, a "graphic mode", displaying various cross-sectional views of the current highwall/bench pair is available upon user request.

B. MODULE DESCRIPTION

The General Mine Description module is comprised of three major executives: GDE, DLGE, and TSGE. GDE allows the user to describe the current mine site, then schedules either DLGE, the Dragline Grading Executive, or TSGE, the Truck and Shovel Grading Executive, to allow

[illegible]

[illegible]

[illegible]

[illegible]

the user to describe the post-mining topography and to determine grading volumes and costs associated with that post-mining description.

C. SUBROUTINE GDE

GDE is the General Description Executive (See Figure 6). GDE is accessed by CLAIM to schedule inputs and edits to the General Mine Description data.

MODE = 1

The user is in the "DATA INPUT" option: "INPUT THE GENERAL MINE DESCRIPTION." The sequence of operations is as follows:

1. GENDE is called to input the category responses to the General Mine Description. If EXIT = 0 upon return from GENDE, GDE terminates.

2. GDE tests the value of "RGENDE(1)."

2.1 If RGENDE(1) = 1 (Dragline Mine), "IOPTN" is set to one and GDE calls

(i) DLOID for the Opening Cut (RGENDE(2) = 1)

(ii) DLMID for the Mine Run ORGENDE(2) = 2)

(iii)DLFID for the Final Cut (RGENDE(2) = 3)

to input the initial spoils grading data. Subroutine DLGE is then called (provided EXIT ≠ 0), and GDE returns.

2.2 If RGENDE(1) = 2 (Truck and Shovel Mine), GDE reads the cost for grading spoils. If -1, GDE returns; otherwise, TSGE is repeatedly scheduled until the user indicates an exit (in been defined. GDE then terminates.

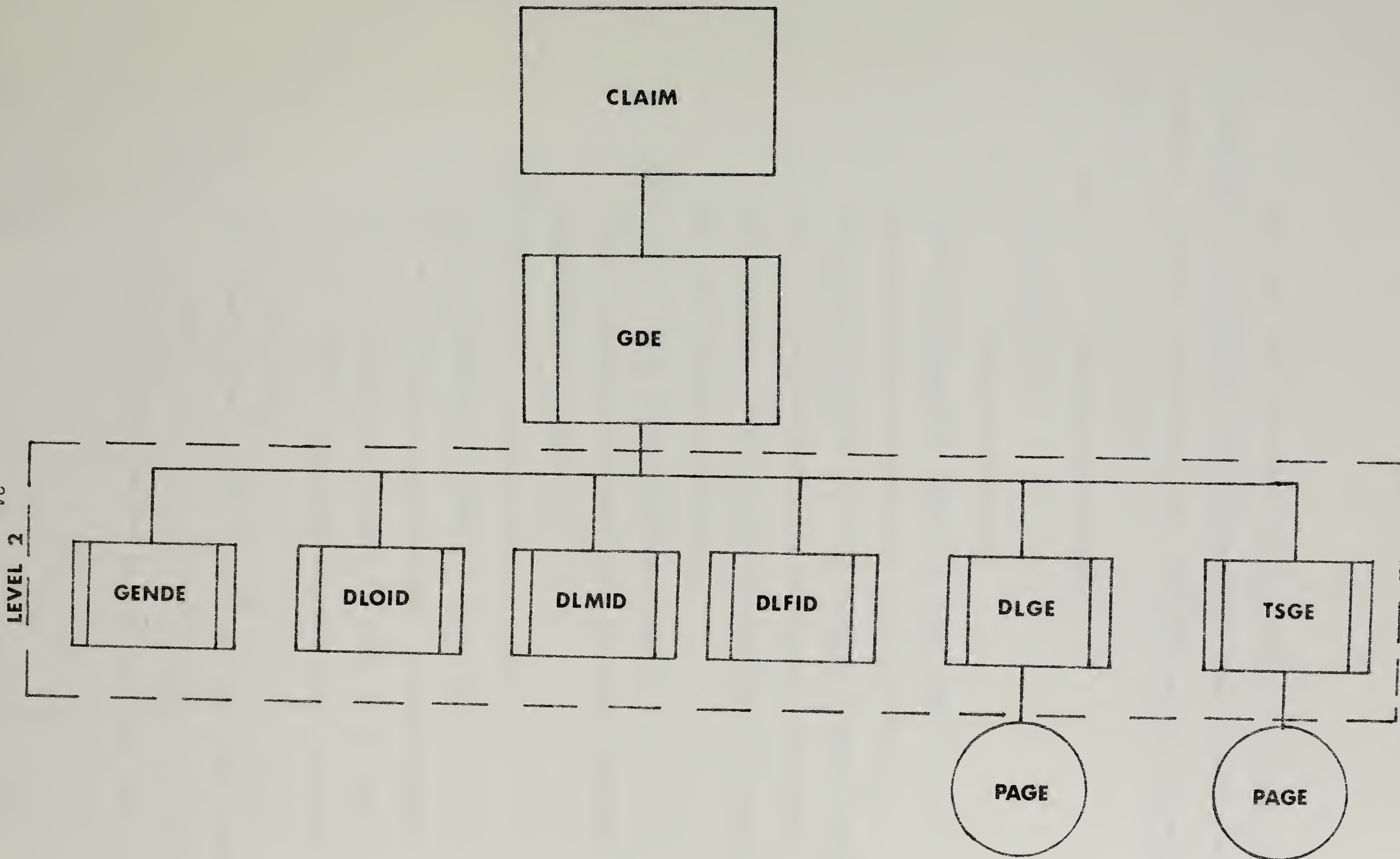


Figure 6. General Mine Description Subroutines.

The user is in the "DATA EDIT" option: "EDIT THE GENERAL MINE DESCRIPTION." GDE branches to 500 and presents a menu offering several options. "IOPTN" is set to the user's selection and the following occurs:

*IOPIN = 0 (Exit from this Option)

GDE returns.

*IOPTN = 1 (Edit type of mine)

GENDE is scheduled to accept the user's edit. If the user actually does change the type of mine (this is determined by testing the local variable "ITYFE"), "MODE" is set to 1 (Input Mode), and the sequence of operations described under "MODE = 1" above is executed. Otherwise, the option never is redisplayed.

*IOPTN = 2 (Edit cost to excavate spoil)

GENDE is scheduled to accept the user's edit, and the option menu is redisplayed.

*IOPTN = 3 (Edit Stage in mining sequence)

GENDE is scheduled to accept the user's edit. If the user actually does change the stage in mining sequence (this is determined by testing the value of the local variable "ISTAGE"), then the following occurs according to the type of mine:

(i) Dragline Mine. "IOPTN" is set to 1 and DLOID, DLMID, or DLFID is called to input the initial spoils grading data, and DLGE scheduled to read the final slope de-

scription and determine grading costs. The option menu is then re-displayed.

(ii) Truck and Shovel Mine. GDE tests for the opening situation. If the user has changed to the opening cut situation, "REHVOL" is set to zero, and subroutine TSST is called to recompute grading costs. If the user has changed to either of the other cut options, no action is required. The option menu is redisplayed.

*IOPTN = 4 (Edit the spoils grading data)

"IOPTN" is changed to 2 for the dragline mine, and the subroutines DLOID, DLMID, or DLFID scheduled, according to the cut option, to edit the initial spoils grading data, and subroutine DLGE called to edit the slope/percent pairs and recompute grading costs. The option menu is redisplayed. For the truck and shovel mine, the user is asked to select the land use alternative he wishes to edit, and subroutine TSGE is scheduled. The option menu is redisplayed.

MODE = 3

The user is in the "DATA EDIT" option: "EDIT EXPECTATION OF SUCCESS VALUES FOR THE GENERAL MINE DESCRIPTION." Subroutine GENDE is scheduled to accept the user's edits, and GDE returns.

MODE = 4

The user is in the "GRADE SPOILS WITHOUT CURRENT LAND USE OPTION RESTRICTIONS" option. The appropriate routines are called as described previously, according to the type of mine and stage in mining sequence.

C1. Subroutine GENDE

GENDE is accessed by GDE to schedule inputs and edits to the following variables:

RGENDE(1) : Type of Mine RGENDE(2) : Stage in Mining Sequence

RGENDE(3) : Average Slope of 10 Random Points

CSTES : Cost to Excavate Spoils

GENDES : General Description Expectation of Success Array.

GENDE uses a full display (see EIFD: IV - c) to present text to other user. "IOPTN" is used as a pointer to the response headings for MODE = 2:

IOPTN = 1 → Edit type of mine

IOPTN = 2 → Edit cost to excavate spoil

IOPTN = 3 → Edit stage in mining sequence

IOPTN = 4 → Edit average slope of 10 random points.

The algorithm executed is similar to that described in Section IV - c, except that "IOPTN" is used instead of "LEXIT."

C2. Subroutine DLOID

DLOID is accessed by GDE to schedule inputs (IOPTN = 1) and edits (IOPTN = 2) to the following common variables associated with the opening cut situation of a dragline mine:

GRDVBS(1) : Height of the spoil bank (feet)

GRDVBS(2) : Average slope of the spoil bank (degrees)

GRDVBS(3) : Length of the spoil bank (yards)

GRDVBS(4) : General slope of the area (degrees)

COGO : Cost of grading spoils (cents/cubic yard)

When in the input mode (IOPTN = 1), DLOID reads the values for each of the above in stepwise fashion. Each value read is checked for validity according to obvious geometrical and logical constraints (e.g, the slope values lie between 0 and 90 degrees, costs and lengths are positive, and the average slope of the area is less than the initial slope of the spoil bank). In addition, the value for GRDVBS (2) is further restricted (see the CLAIM User's Manual) so that it is greater than or equal to 11 degrees ("SLMIN") for MODE = 1 or 2. For MODE = 4, this restriction imposed by the CLAIM system is relaxed to 0.1 degrees. The user may exit from this routine by imputting a value of -1 for GRDVBS (1). After completing all input, or when in the edit mode (IOPTN = 2), DLOZD presents a table of current data and allows selective edits to these data. When in the input mode, "IOPTN" is temporarily assigned the value of 3 during this stage to distinguish it from the stepwise execution required during initial input, and set back to prior to termination.

C3. SUBROUTINE DLMID

DLMID is accessed by GDE to schedule inputs (IOPTN = 1) and edits (IOPTN = 2) to the following common variables for the mine run option of a dragline mine:

GRDVBS (1)	:	Distance between spoil bank peaks (feet)
GRDVBS (2)	:	Slope of the spoils (degrees)
GRDVBS (3)	:	Area covered by the spoils (acres)
GRDVBS (4)	:	General slope of the area (degrees)
COGO	:	Cost of grading spoils (cents/cubic yard)

DLMID uses an algorithm similar to that described under DLOID in B-1.2 above.

A message is displayed when the user describes a general slope in excess of 5.7 degrees (see the CLAIM user's Manual) to the effect that the cropland alternative will not be available as a feasible reclamation option.

C4. SUBROUTINE DLFID

DLFID is accessed by GDE to schedule inputs (IOPTN = 1) and edits (IOPTN = 2) to the following common variables for the final cut situation of a dragline mine:

WBP	:	Width of the bottom of the pit (feet)
GRDVBS(1)	:	Length of the pit (feet)
GRDVBS(2)	:	Height of the highwall (feet)
GRDVBS(3)	:	Height of the spoil bank (feet)
GRDVBS(4)	:	Slope of the highwall (degrees)
GRDVBS(5)	:	Slope of the spoil bank (degrees)
COGO	:	Cost of grading spoils (cents/cubic yard)

DLFID employs an algorithm similar to that described under DLOID in (C2) above, with the same slope restrictions.

D. SUBROUTINE DLGE

DLGE, the Dragline Grading Executive, is accessed by GDE to allow the user to describe the post mining topography and to compute costs and volumes associated with grading to that topography (See Figure 7 for a summary of DLGE subroutines.) DLGE first offers the user the option of

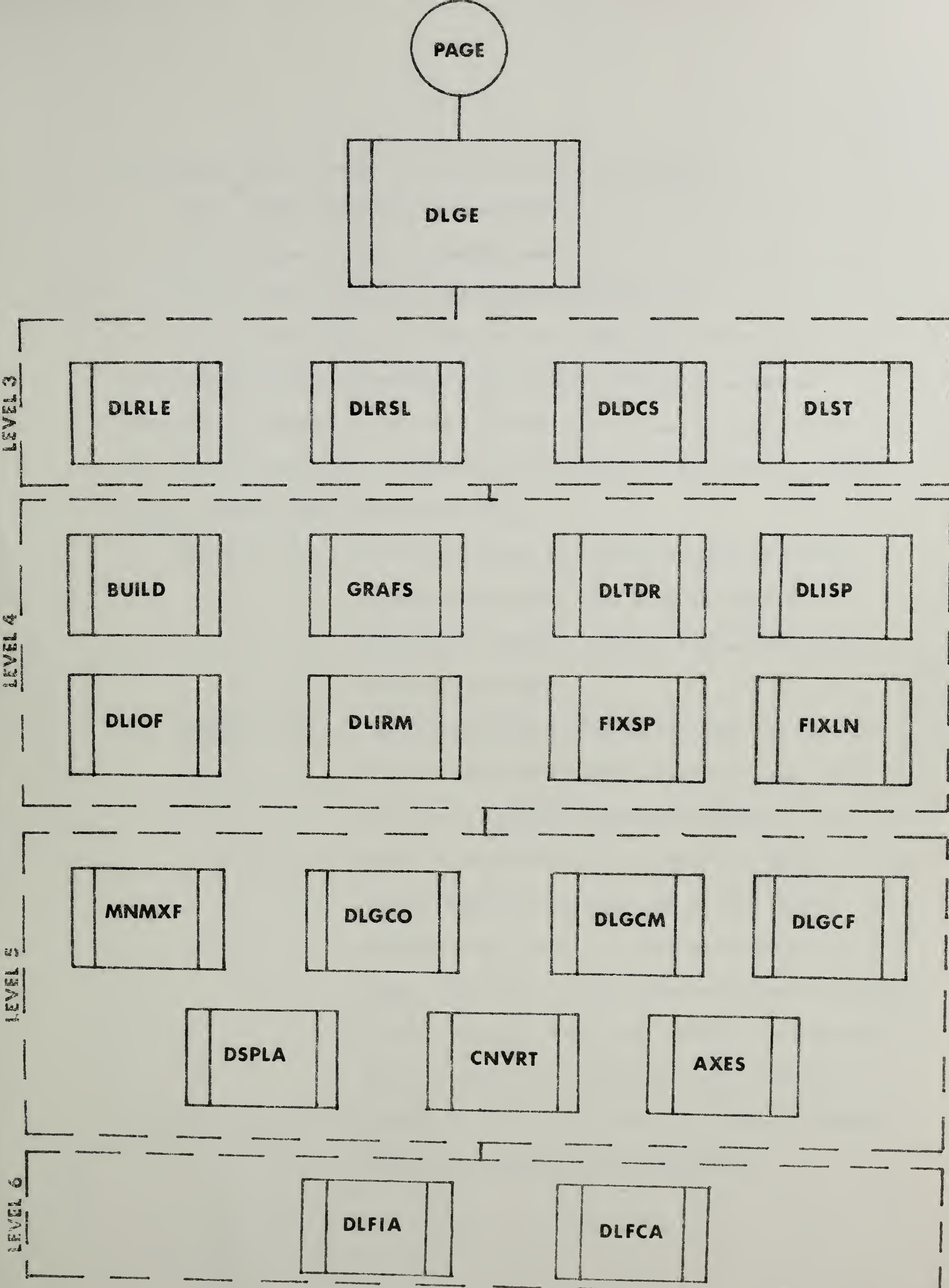


Figure 7. Dragline grading modules.

viewing graphs or tables of the dragline relationships:

(i) Final slope vs. volume graded

(ii) Final slope vs. grading cost

(iii) Final slope vs. final width (opening cut)

or Final slope vs. cost per acre (Mine run, final cut).

If the user elects to implement this feature, DLRLE is scheduled. (Obviously, graphs will not be available if the user's terminal does not have erase capability.) Depending on the value of the pointers "MODE" and/or "IOPTN", the following occurs:

*MODE = 4. Subroutine DLISP is called to input the final slope/percent pairs, and DLST is scheduled to display the summary table of volumes and costs. DLGE then returns.

*MODE = 1 or 2. Subroutine DLRSL is called to input the remended slope cost-percent pairs if the user has not previously described these data (MODE = 1, or MODE = 2 and IOPTN = 1). Subroutine DLDCS is then scheduled to display the current slope/percent pairs and allows user modification to them. Grading costs are then determined by calling DLGCO (for the opening cut), DLGCM (for the mine run), or DLGCF (for the final cut). DLST is scheduled if the user elects to view the summary table for a specific land use option.

D1. SUBROUTINE DLRLE

DLRLE, the Dragline Relationship Executive, is accessed by DLGE to present graphs or tables of the dragline relationships listed above. The graphs and tables have been organized under this executive in anticipation of further developments in this area. Currently, this executive simply:

1. Calls BUILD to initialize the variables declared in label common TABLE (See Appendix B). BUILD returns an "IPNTR" value of 3 if graphs or tables are not available.

2. Calls GRAFS to draw graphs of the dragline relationships (IPNTR = 1)

3. Calls DLTDR to present a table of the dragline relationships (IPNTR = 2). The user is required to specify the output service (terminal or line printer) before the DLTDR call.

D2. SUBROUTINE BUILD

BUILD is accessed by DLRLE to build tables of the dragline final slope relationships. The table arrays are declared in lable common TABLE and definedin appendix B. BUILD first calls subroutine MNMXF to determine the current minimum and maximum final slopes permitted for the present situation, then asks the user to input the lower and upper final slope values in which he is interested. This user-entered interval (provided it falls within the interval determined by MNMXF), is divided into 10 sub-intervals.

Depending on the cut option, DLGCO (opening cut), DLGCM (mine run), or DLGCF (final cut) are called to compute the grading costs and volumes associated with each sub-interval slope value.

D3. SUBROUTINE MNMXF

MNMXF is accessed by BUILD and DLISP to return the maximum and minimum final slope values for the current situation. These values are dependent on the cut option and mode of operation. For MODE = 4, the values are determined by geometry alone; for other values of MODE, the CLAIM restrictions as defined in the CLAIM User's Manual are implemented.

MNMXF does not declare the CLAIM common block. The calling sequence is:

call MNMXF (LUT, MODE, KCUT, GRDVBS, TSMAX, TSMIN, KCODE) where

LUT is the logical unit of the user's terminal

MODE is the mode indicator (as defined in CLAIM common)

KCUT is the cut option (as defined by RGENDE (2) in CLAIM common)

GRDVBS is the grading variables array (as defined by CLAIM common)

TSMAX is the maximum final slope value

TSMIN is the minimum final slope value

KCODE is a switch where

KCODE = 1 → Read TSMAX and TSMIN from the user

KCODE = 2 → Return TSMAX, TSMIN directly

KCODE = 3 → TSMIN, TSMAX are equal

D4. SUBROUTINE DLGCO

DLGCO is accessed by BUILD, DLGE, and DLST, to compute grading costs and volumes for the opening cut situation of a dragline mine.

DLGCO declares label common TABLE, but does not declare the CLAIM common blocks. The calling sequence is:

call DLGCO (SLOP, PCT, VOL, COST, CPA, GROVBS, COG, WIDTH) where

SLOP is the final slope desired on the highwall (degrees)

PCT is the percentage of the area to be graded to SLOP

COST is the cost to grade spoils (dollars)

VOL is the volume graded (cubic yards)

CPA is the cost to grade to SLOP?PCT (Dollars/acre)

GRDVBS is the grading variables array as defined on CLAIM common

COG is the cost of grading spoils (cents/cubic yard)

WIDTH is the final width of the spoil bank (feet)

Figure 8 shows the geometry of the opening cut. The letters in the figure correspond to the local variables in DLGCO. Starting with the assumption that the area of triangle ABT is equal to the area of triangle XYS, the following steps are initiated (after GROVBS entries are renamed to correspond to the labeling in Figure 8):

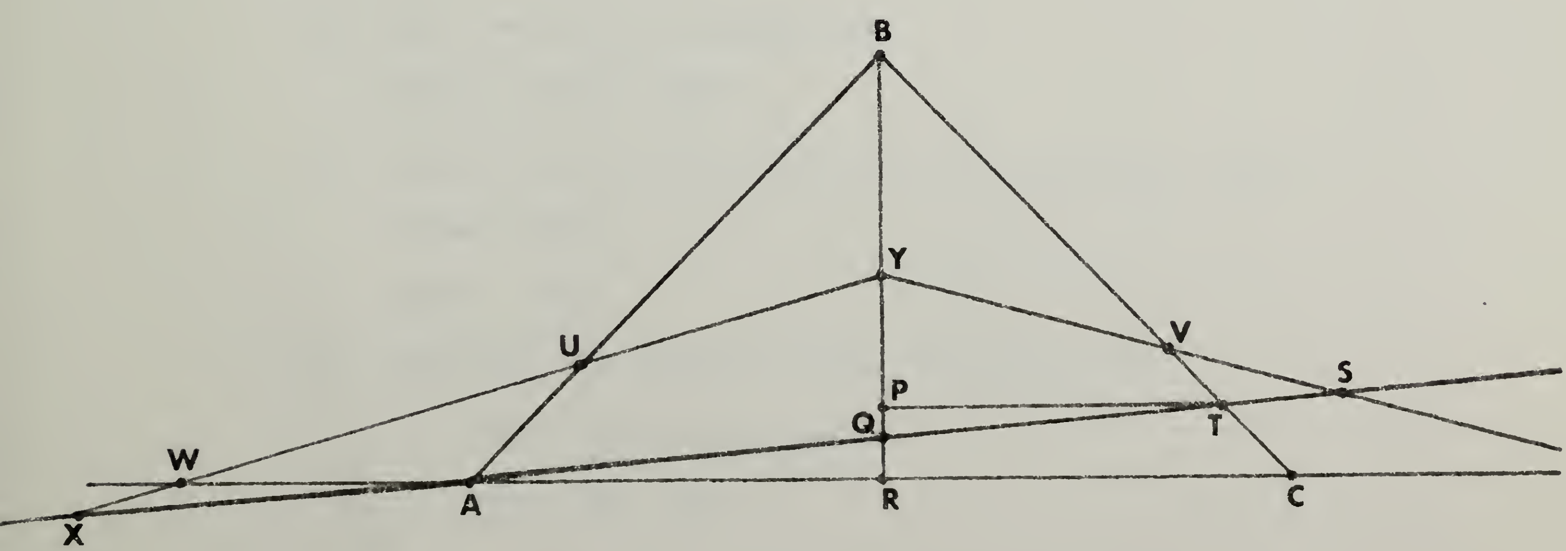


Figure 8. Opening Cut Geometry

A) Convert BQ from feet to yards. BQ1 = BQ/3.

B) Find the area of triangle BAQ.

1) BAR = initial slope

2) BAQ = BAR - QAR

3) BQA = 90 + QAR

4) ABQ = 180 - BAQ - BQA

5) Area of triangle BAQ is:

$$\text{ATBAQ} = \frac{(\text{BQ1} \times \text{BQ1}) \times \sin(\text{ABQ}) \times \sin(\text{BQA})}{2 \times \sin(\text{BAQ})}$$

C) Find the area of triangle BTQ.

1) BTP = initial slope

2) BTQ = BTP + QAR

3) BQT = 90 - QAR

4) QBT = 180 - BTQ = BQT

5) Area of triangle BTQ is:

$$\text{ATBTQ} = \frac{(\text{BQ1} \times \text{BQ1}) \times \sin(\text{BQT}) \times \sin(\text{QBT})}{2 \times \sin(\text{BTQ})}$$

D) Find the area of triangle BAT.

ATBAT = ATBAQ + ATBTQ

E) Assume that the area of triangle XYS equals the area of triangle BAT.

ATXYS = ATBAT

F) Calculate the internal angles of triangle XYS.

1) YWR = final slope desired

2) YXQ = YWR - QAR

3) XYQ = 90 - YWR

4) YSX = YWR + QAR

5) QYS = XYQ

6) XYS = XYQ + QYS

7) YXS = YXQ

G) Calculate the value of XY.

We know that

$$ATXYS = \frac{(XY) \times (XY) \times \sin(XYS) \times \sin(YXS)}{2 \times \sin(YSX)}$$

$$\text{So, } XY = \frac{ATXYS \times 2 \times \sin(YSX)}{\sin(XYS) \times \sin(YXS)}$$

H) Calculate the value of YS.

We know that

$$ATXYS = \frac{(YS) \times (YS) \times \sin(YSX) \times \sin(XYS)}{2 \times \sin(YXS)}$$

$$\text{So, } YS = \frac{ATXYS \times 2 \times \sin(YXS)}{\sin(YSX) \times \sin(XYS)}$$

I) Now find the area of triangle BVY.

1) YQS = BQT

2) YSQ = YWR + QAR

3) Area of triangle YSQ

$$ATYSQ = \frac{(YS) \times (YS) \times \sin(QYS) \times \sin(YSQ)}{2 \times \sin(YQS)}$$

4) Calculate the values of QS and QT.

$$QS = \frac{ATYSQ \times 2 \times \sin(QYS)}{\sin(YSQ) \times \sin(YQS)}$$

$$QT = \frac{ATBTQ \times 2 \times \sin(QBT)}{\sin(BQT) \times \sin(BTQ)}$$

5) TS = QS - QT

6) VST = YSQ

7) STV = 180 - BTQ

8) TVS = 180 - VST - STV

9) Calculate the value of VS:

$$\frac{\sin(STV)}{VS} = \frac{\sin(TVS)}{TS}$$

$$\text{So, } VS = \frac{\sin(STV) \times TS}{\sin(TVS)}$$

10) YV = YS - VS

11) YBV = QBT

12) BVY = TVS

13) BYV = 180 - YBV - BVY

14) The area of triangle BVY is

$$ATBVY = \frac{(YV) \times (YV) \times \sin(BVY) \times \sin(BYV)}{2 \times \sin(YBV)}$$

J) Now find the area of triangle BUY:

1) Calculate the value of BY

$$\frac{\sin(BVY)}{BY} = \frac{\sin(YBV)}{YV}$$

$$\text{So, } BY = \frac{\sin(BVY) \times (YV)}{\sin(YBV)}$$

2) UBY = ABQ

3) BUY = BAR - YWR

4) BYU = 180 - UBY - BUY

5) Area of triangle BUY is:

$$ATBUY = \frac{(BY) \times (BY) \times \sin(UBY) \times \sin(BYU)}{2 \times \sin(BUY)}$$

The total area of the cross-section of the overburden to be moved is equal to the sum of the areas of triangles BUY and BVY. So:

AREA = Total Cross section area = ATBUY + ATBVY.

The length of the spoil bank, to which a particular final slope is to apply, is determined by multiplying the percent by the total length of the bank.

$$PLEN = \frac{PCT}{100} \times TLSB$$

The volume for that slope is determined by multiplying the PLEN by the cross-sectional area AREA.

VOL = PLEN x AREA

The cost of moving that volume is determined by multiplying the volume by the cost per cubic yard of grading.

COST = VOL x COMO.

D5. SUBROUTINE DLGCM

DLGCM is accessed by BUILD, DLGE, and DLST to compute grading costs and volumes for the mine run option of a dragline mine. DLGCM declares label common TABLE, but does not declare the CLAIM common block. The calling sequence is:

call DLGCM (SLOP, PCT, VOL, COST, TLSB, GROVBS, COG) where

SLOP is the final slope desired on the spoil banks (degrees)

PCT is the percent of the area to be graded to SLOP

VOL is the volume graded (cubic yards)

COST is the cost to grade spoils (dollars)

TLSB is the hypothetical total length of a spoil bank covering the same acreage as the mine run spoils (feet)

GRDVBS is the grading variables array as defined in CLAIM common

COG is the cost of grading spoils

Figures 9 and 10 show the geometry of the mine run option. The letters in Figure 10 correspond to the local variables in DLGCM. The following describes the assumptions made and the methodology employed.

Assumptions Made:

1) That each spoil bank may be considered to have a straight line top and the same slope on each side. (Figure 9)

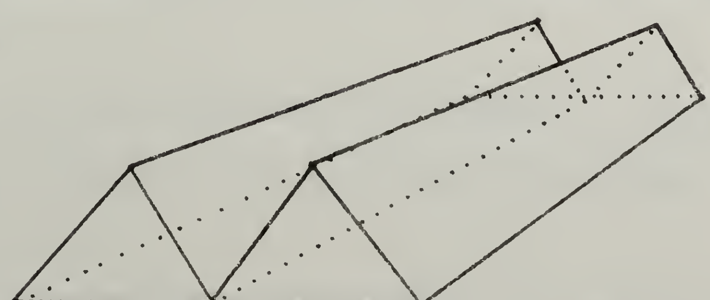
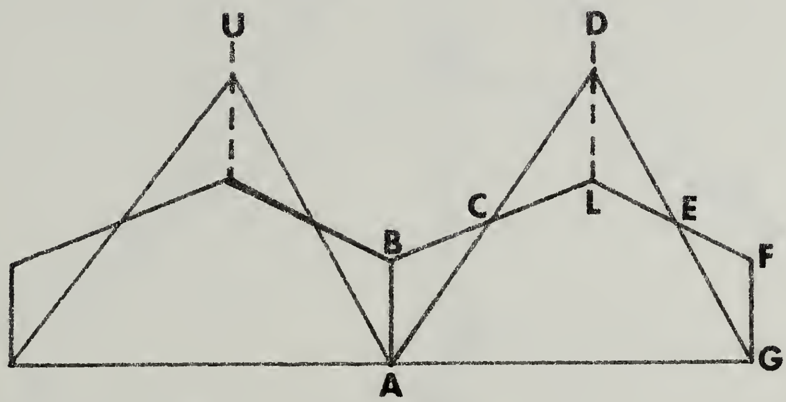


Figure 9. 45° View of the Mine Run Spoils.

2) That triangle ABC is equivalent (≡) to triangle CDL. (Figure 10).



Similarly,

ΔDEL ≡ EFG

Figure 10. Cross-sectional view of raw and graded spoils

1) Triangles will be referred by the symbol "Δ" followed by the letters corresponding to the three vertices of the triangle (e.g., ΔABC).

2) That the area of the triangle ABC is equivalent (≡) to triangle CDL.

Notation:

1) Triangles will be referred by the symbol "Δ" followed by the letters corresponding to the three vertices of the triangle (e.g., ΔABC).

2) Angles will be referenced by the symbol "<" followed by the letters corresponding to the vertix and the endpoints. In ABC, the vertex is a B.

3) Line segments will be referenced by the letters corresponding to the endpoints (e.g., AB).

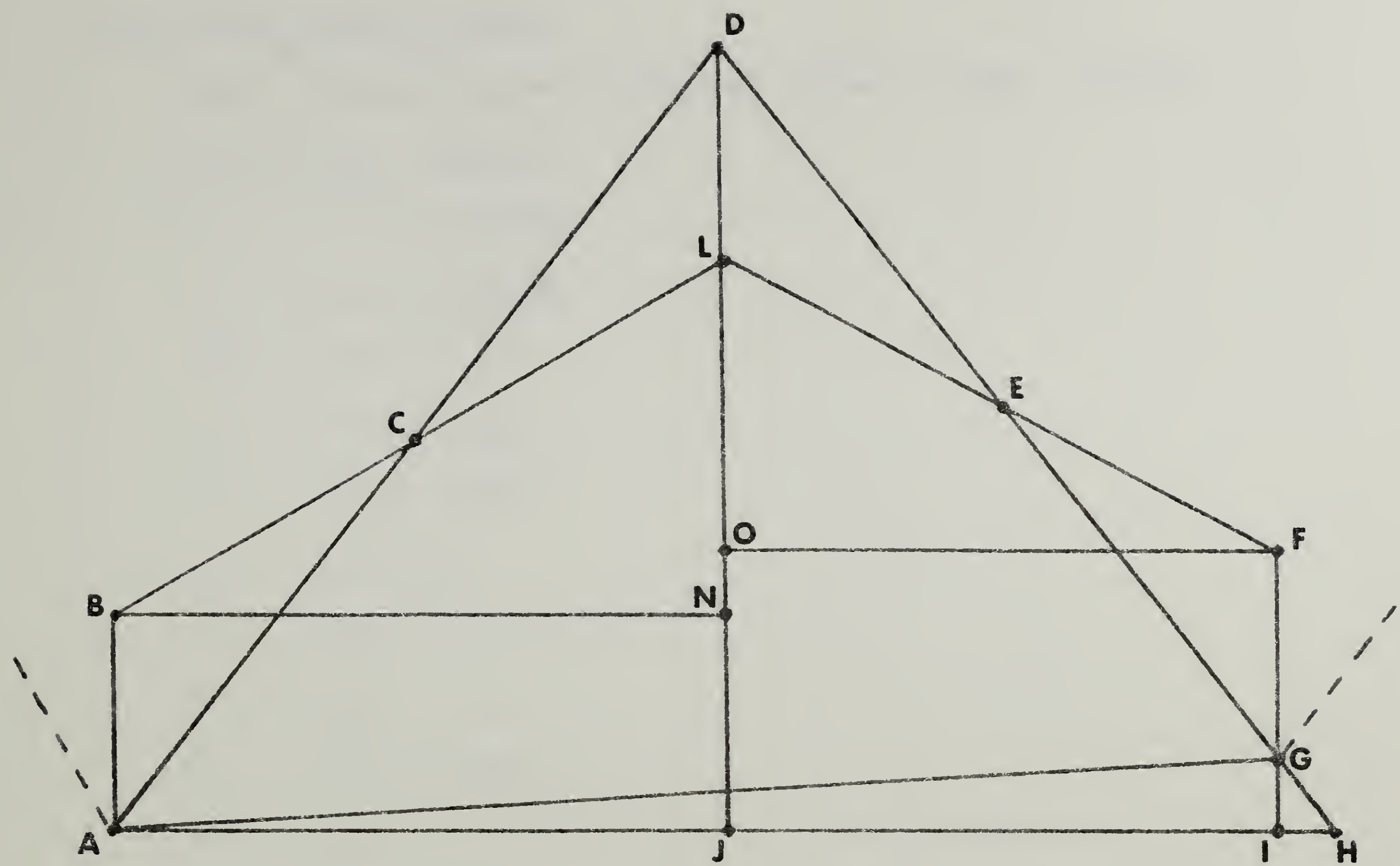


Figure 11. Geometry of the mine run spoils.

The overburden whose cross-section is described by ΔCDL is moved to the area described by ΔABC. The overburden in ΔDEL is moved to ΔEFG. The objective is to find the areas of ΔCDL, and ΔDEL. It is known that:

1) AG is equal to the average distance in feet between spoil bank peaks (DBSBP).

2) <DAH is known, equal to the initial slope of the banks.

3) <GAH is known, equal to the general slope of the area.

4) Goth DAH and GAH are given in degrees.

5) <LBN = LFO = final slope desired.

Calculation of area of ΔDCL:

DBSBP = Distance Between Spoil Bank Peaks, in feet. (given)

AG, in yards = DBSBP/3.

GI = AG x sin (<GAH)

AI = AG x cos (<GAH)

<DHA = <DAH

IH = GI/tan (<DHA)

GH = GI/sin (<DHA)

AH = AI + IH

AJ = AH/2

HJ = AH/2

AD = AJ/cos (<DAH)

CD = AD/2

<DCL = <BAC = 90° - <DAH

<DCL = 90° - <LBN - <CDL

<DLC = 180° - <CDL - <DCL

<RCDL = CDL in radians = <DCL x .01745

<RDCL = <DCL in radians = <DCL x .01745

<RDLC = <DLC in radians = <DLC x .01745

$$\text{Area of } \Delta DCL = \frac{(DC \times CD) \times \sin(<RCDL) \times \sin(<RDCL)}{2 \times \sin(<RDLC)}$$

Calculation of area of ΔDEL:

DH = HJ/cos (<DHA)

DG = DH - GH

DE = DG/2

<EDL = 90° - <DHA

<DLE = 90° - <LFO

<DEL = <DHA - <LFO

<REDL = <EDL in radians = <EDL x .01745

<RDLE = <DLE in radians = <DLE x .01745

<RDEL = <DEL in radians = <DEL x .01745

$$\text{Area of } \Delta DEL = \frac{(DE \times DE) \times \sin(<REDL) \times \sin(<RDEL)}{2 \times \sin(<RDLE)}$$

Total area of crossection of overburden to be moved:

Total Area = Area of ΔDCL + Area of ΔDEL

Calculation of hypothetical total length of all spoil banks, given the total area of all the spoils (in acres).

1) Calculate the area of the spoils, in square yards.

TASA = total area of spoils in acres

TASY = total acre of spoils in square yards

TASY = TASA x 4840

2) Find the length, in yards, of a square having area equal to that of the spoils. In other words, take the square root of TASY.

SHEAY = length, in yards, of a square having area equal to that of the spoils. It is computed as follows:

SHEAY = SORT(TASY)

3) Convert SHEAY to feet

SHEAF = SHEAY x 3

4) Divide SHEAF by the distance between spoil bank peaks, to get the number of banks.

BANKS = SHEAF/DBSBP

5) Multiply the number of banks (BANKS) by the length of the square, in yards, to get the total length of all the spoil banks in yards.

TLSB = total length of all spoil banks

TLSB = BANKS x SHEAY

<u>Calculation of Volume of Overburden to be Graded</u>:

VOLUME = area of crossection of overburden to be moved x total length of all the spoil banks.

VOLUME = total crossection area x TLSB, in cubic yards.

COST = volume to be moved x cost per cubic yard of moving overburden.

Average cost per acre = COST/TASA

D6. SUBROUTINE DLGCF

DLGCF is accessed by DLGE, BUILD and DLST to perform grading calculations for the final cut stage of a dragline mine. As can be seen from Figure 12, the final cut option is comprised of a highwall and a spoil bank--both of which are graded to the same final slope. DLGCF computes the volume of material graded, the costs associated with grading that material, and the final acreage covered by the graded highwall and spoil bank, based on previously described spoils grading parameters (See DLFID (III-C4)).

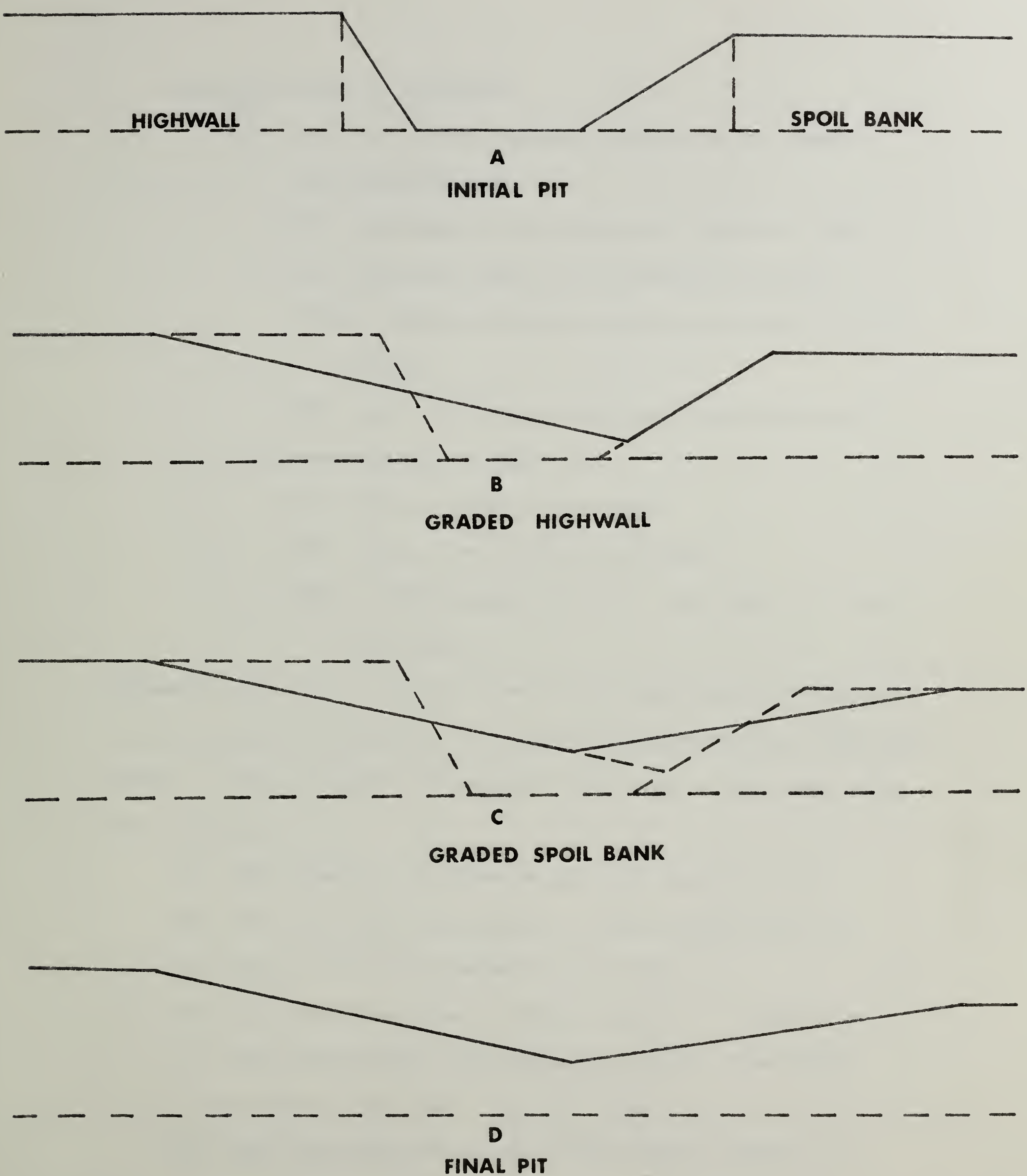


Figure 12. Cross-sectional views of the final cut grading sequence.

Arguments passed to DLGCF are:

SLOP - the final slope (degrees) desired on the highwall and the spoil bank

PCT - the percent of the area to be covered by SLOP

WBP - the width (feet) at the bottom of the pit

GRDVBS - grading variables array as described in DLFID (III-C4)

COGO - Cost of grading overburden (cents/cubic/yard)

Parameters returned by DLGCF are:

VOL - Volume graded (cubic yards)

COST - Total cost of grading (dollars)

ACRES - Graded acreage (acres). Also used as an error return call.

Frequent references to Figures 13 and 14 are made throughout this discussion and the description of the two following subroutines (DLFIA and DLFCA). Local variables correspond to the labels in diagrams, using the convention:

(i) Line segments are referenced as a two letter variable, where the first letter corresponds to the starting point, and the second letter to the endpoint of the line.

(ii) Angles are identified by three letters "---", where "---" is a three letter label with the center letter corresponding to the vertex of the angle. eg. ACB = BCA

(iii) Areas are identified by the letters "AR---", where "---" is a three letter label outlining the area in point.

All angles are in degrees. Whenever a trigonometic function is sought, the angle is multipled by the local variable "CDTR" which converts degrees to radius (CDTR = $\pi/180 = 0.01745$). Where necessary in this routine, the number 1 or 2 is appended to the variable name described above to distinguish between Phase 1 and Phase 2 results (see below). Figures 13 and 14 depict the following situations:

(i) Highwall Grading Situation 1 (Figure 13(A):

This diagram depicts the situation when, after grading down the highwall, the highwall slope face does not reach the toe of the spoil bank (Point D). In this case, the area graded is that bounded by AGI.

(ii) Highwall Grading Situation 2 (Figure 13B):

In this case, the highwall slope face passes the spoil bank toe. The method employed is to proceed as if the situation were as described in (i) above, then correct the area by subtracting the area of GHTI from AGI, and finding the lengths GH and JK, which corrects for spoil overlap in the area JDL (Figure 13(B).

(iii) Spoil Bank Grading - Situation 1 (Figure 14(A):

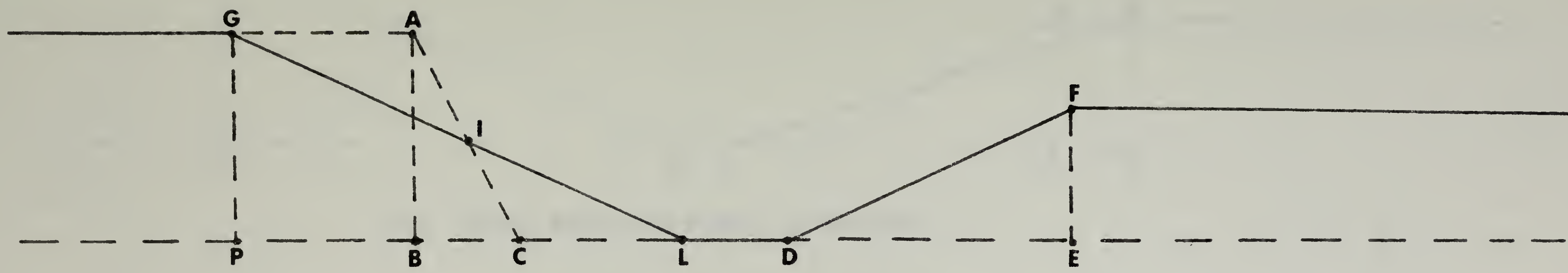
This may occur when Highwall grading situation 1 occurs. In the area graded is that bounded by AGI. The total graded area is given, then, by:

$$TA = \text{Area }(AGI)_{HW} + \text{Area }(AGI)_{SB}$$

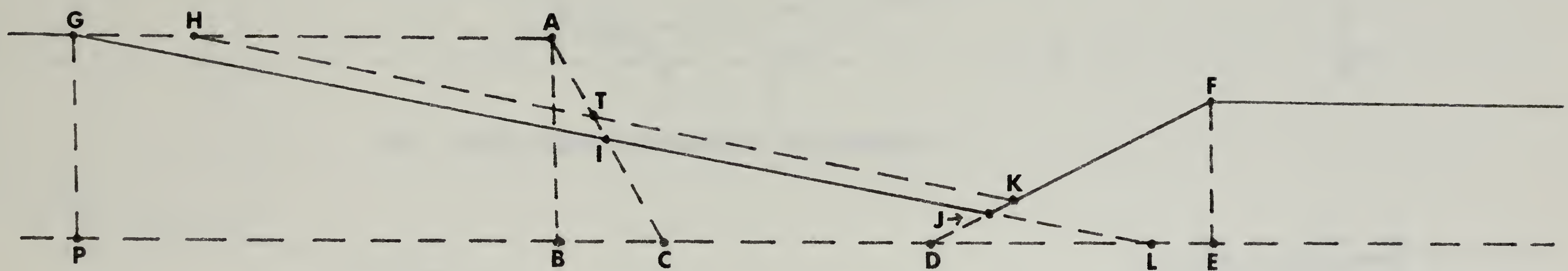
where "HW" and "SB" refer to the highwall and spoil bank respectively.

(iv) Spoil Bank Grading - Situation 2 (Figure 14(B):

In this case, which occurs for highwall grading situation 1 (Figure

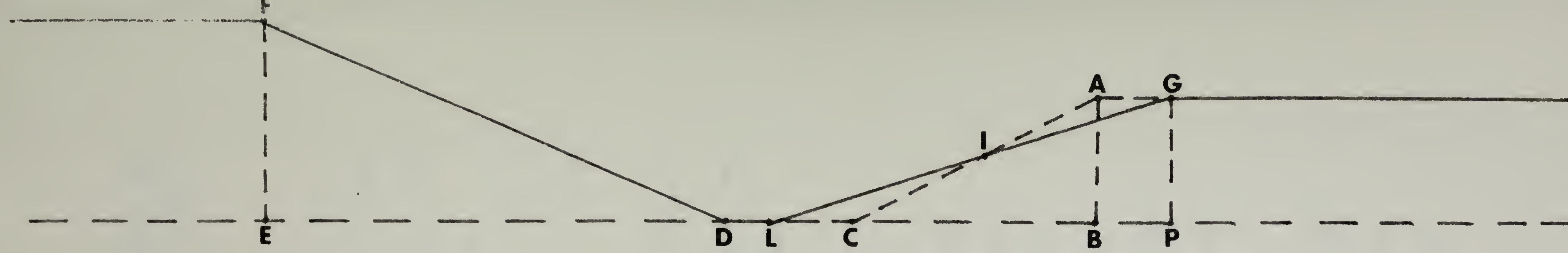


(A): HIGHWALL GRADING SITUATION 1

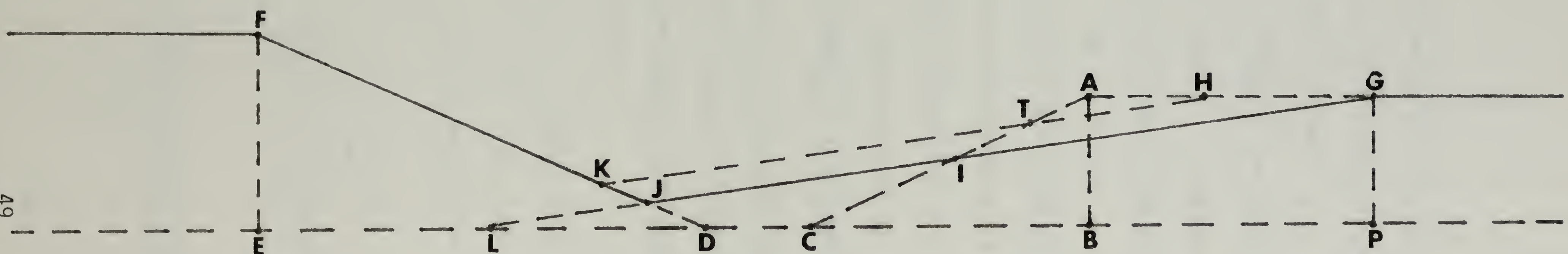


(B): HIGHWALL GRADING SITUATION 2

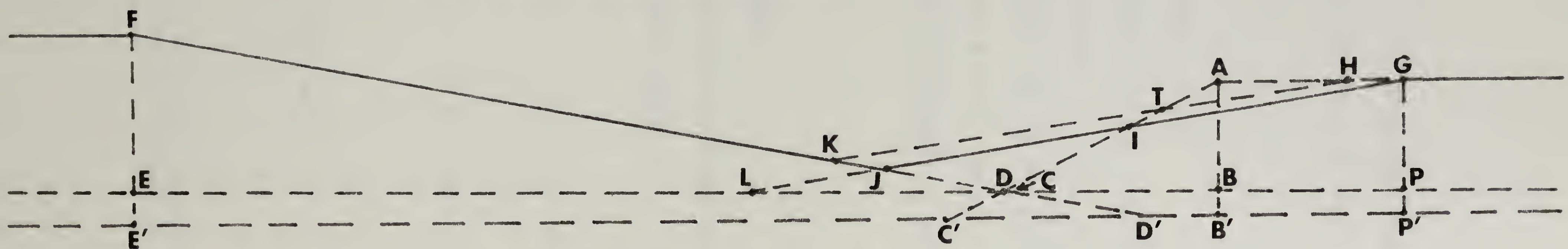
Figure 13. Highwall Grading Situations.



(A): SPOIL BANK GRADING SITUATION 1



(B): SPOIL BANK GRADING SITUATION 2



(C): SPOIL BANK GRADING SITUATION 3

Figure 14. Spoil Bank Grading Situations,

13(A), the spoil bank face reaches the toe of the graded highwall. The method here is identical to that described in (ii) above. The total graded area is, then:

$$TA = \text{Area } (AGI)_{HW} + \text{Area } (AHT)_{SB}$$

(v) Spoil Bank Grading - Situation 3 (Figure 14(C):

This situation occurs when highwall grading situation 2 prevails (Figure 13(B). The net effect of the highwall correction described in (ii) above is to "raise" the ground level (BB´ in the diagram). The input data are correspondingly adjusted by the program to conform to the BB´ correction, and grading is achieved as described in (ii) above. The total area is:

$$TA = \text{Area } (AHT)_{HW} + \text{Area } (AHT)_{SBA}$$

where SBA denotes the "adjusted" spoil bank.

Note: Volumes are obtained by multiplying the cross-sectional areas determined above by the appropriate length. This length is:

$$L = (P/100)(TL)$$

where P is the percent of the area to be graded to the current line 1 slope value, and TL is the total length of the final cut pit.

This routine does not consider the "ends" of the pit, which meet undisturbed land.

The following assumptions are made:

1. Line Ab is parallel to line BP (all diagrams)*

---

* Labels in figures 13 and 14 are not fixed from situation to situation - rather, the diagrams are labeled according to arguments passed to DLFIA and DLFCA.

2. No swelling of the highwall overburden occurs.

3. GP is parelled to FE, and perpendicular to BP.

4. All slopes are measured from a line perpendicular to a "plumb bob". (AG has a slope of zero degree).

5. Point "I" bisects the lines AC and GL

The subroutine DLGCF is comprised of three phases:

1. Grading down the highwall.

2. Grading down the spoil bank.

3. Volume; cost, and area calculations.

These are discussed in turn.

Phase 1: Grade down the highwall

First, subroutine DLFIA is called to determine the area bounded by triangle AGI in Figure 13(A and B). Line GA is then tested: If GA > CD, then situation 2 prevails, and DLFCA is called to correct the cross-sectional area AGI returned by DLFIA--otherwise, situation 1 is identified and no correction is needed. The variable "CD" is now adjusted: For situation 1, CD = LD, otherwise we set CD = 0.

Phase 2: Grade down the spoil bank.

First, we test the value of CD: If non-zero, we skip the following three steps; which find AB in Figure 14(C):

1. Reference Figure 13(B):

   DJ = JL sin (JLD)/sin (JDL) -(Law of sines)

   DK = DJ + JK

2. Reference Figure 14C: Note that C´D in Figure 14C corresponds to DK in Figure 13B =

   C´D = DK

   B´B = C´D sin (ACB)

   (The labels C and D define the same point, since CD = 0)

3. Now adjust the initial spoil bank height:

   AB = AB´ - BB´, where AB´ is the initial SB height.

Next, a call to DLFIA returns the cross-sectional area of triangle AGI. If GA > CD (GA is returned by DLFZA), then DLFCA is called to correct overgrading, otherwise, we proceed to Phase 3.

Phase 3: Calculate Volume, Cost, and Area

The volume is given by:

VOL = (AP1 + AP2)(PCT/100)(GRDVBS(1))/19

where AP1 and AP2 are the cross-sectional areas determined in Phase 1 and 2, respectively. We divide by 9 to convert the volume to cubic yards:

(i) GRDVBS(1) is multiplied by 3 to convert the length of the pit from yards to feet.

(ii) The result is divided by 27 to convert from cubic feet to cubic yards (AP1 and AP2 are in square feet).

The cost is simply:

COST = VOL * COG/100.

(We divide by 100 to convert from cents to dollars)

The final area for this slope/percent pair, as would be determined by contours on a topographic map, is the initial area (BC + CD + DE: Figure 13(A) times length) plus the additional area obtained by grading ($AH_{HW} + AH_{SB}$ or $AG_{HW} + AG_{SB}$ times length).

D7. Subroutine DLFIA

DLFIA is accessed by DLGCF to compute the initial, uncorrected cross-sectional area of material that has to be graded to achieve the final topography previously specified by the user. The cross-sectional area determined by this routine is that area bounded by the triangle GAI in Figures]3 and]4, for all situations depicted.

Arguments passed to DLFIA are:

AB - vertical height (feet) of eigher the highwall (phase 1) or the spoil bank (phase 2)

AGI - Final slope (degrees) of the highwall (or the spoil bank)

ACB - Initial slope (degrees) of either the highwall (phase 1) or the spoil bank (phase 2)

Parameters returned by DLFIA are:

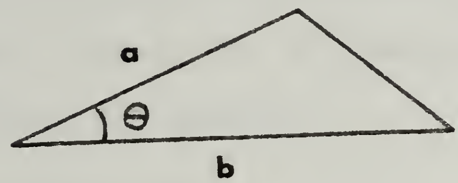
PL - Width (feet) of final highwall (or spoil bank)

BC - Width (feet) of initial highwall (or spoil bank)

GA - Width (feet) of highwall (or spoil bank) removed by grading

ARAGI - Area (square feet) graded

The method is to find the length of 2 sides so that, in conjuction with the angle AGI, we can employ the following formula:



AREA = ! a b sin Θ

The two lengths sought here are GA and GI. To determine GA, we find the lengths PL and BC:

PL = AB/tan (AGI)

BC = AB/tan (ACB)

Then, GA is given by:

GA = ! (PL - BC)

since we assume that GA is equal to CL (No swelling of overburden).

To determine GI, we need the angles GAI and AIG so that we can use the Law of sines:

GAI = 180 - ACB

AIG = 180 - AGI - GAI

GI = GA sin (GAI)/sin (AIG)

Then the area is:

ARAGI = ½ (AG)(GI)(sin(AGI))

D8. Subroutine DLFCA

DLFCA is accessed by DLGCF to correct the cross-sectional area computed by DLFIA. This routine is called whenever Situation 2 of Phase 1 (Highwall Grading - Figure 13), or Situations 2 or 3 of Phase 2 (Spoil Bank Grading - Figure 14) prevails.

Arguments passed to DLFCA are:

- PL - Width (feet) of the final highwall (Phase 1), or the final spoil bank (Phase 2)
- BC - Width (feet) of the initial highwall (Phase 1), or the initial spoil bank (Phase 2)
- GA - Width (feet) of the highwall (Phase 1) or the spoil bank (Phase 2) removed by grading
- CD - Width (feet) at the bottom of the pit. (This is the present width, and may differ from the initial width specified by the user in subroutine DLFID)
- ACB - Initial slope (degrees) of the highwall (Phase 1) or the spoil bank (Phase 2)
- FDE - The initial slope (degrees) of the spoil bank (Phase 1) or the final slope (degrees) of the highwall (Phase 2)
- AGI - The final slope (degrees) of either the highwall or the spoil bank (these are the same). Note that FDE is equal to AGI for Phase 2.

Parameters returned by DLFCA are:

- ARGHTI - Area (square feet) needed to correct ARAGI (see DLFIA)
- GH - Correction (feet) on the highwall (Phase 1) or the spoil bank (Phase 2)
- JK - Correction (feet) on the spoil bank slope (Phase 1) or the highwall slope face (Phase 2)
- JL - Correction (feet) to the face of the highwall slope (Phase 1) or the spoil bank slope face (Phase 2)
- KERR - Error return call. φ = no errors, -1 = error

The method is to first find the area of triangle JDL (see Fig. 13 & 14). This is done in a manner similar to that employed by DLFIA. The two lengths we seek here are JL and DL. The length DL is found by:

$$DL = PL - GA - BC - CD$$

To determine JL, we find the angle DJL and use the law of sines:

$$DJL = 180 - FDE - AGI$$

$$JL = DL \sin FDE / \sin DJL$$

The area is, then

$$ARJDL = (\tfrac{1}{2})(JL)(DL)(\sin AGI)$$

Next, we find the lengths GH and JK which correct the overgrading. Figure 15-A illustrates the approach used. "B" in the figure corresponds to the line GJ in Figures 13 & 14. The area of JDL is equal to the area of GHJK.

$$GL = PL/\cos (AGI) \text{ since } AGI = GLP$$

$$GJ = GL - JL$$

Now, find the descriminant of the quadratic equation and test for real roots. "Θ" in Figure 15-A corresponds to angle AGI, and "ϕ" to angle HKJ.

$$D = (GJ)^2 + 2(ARJDL)(1/\tan HKJ - 1/\tan AGI)$$

If D < 0, the roots are complex conjugate and have no physical meaning, so we set KERR to 1 and return. Otherwise, the roots are real and we seek the positive root:

$$H = (\sqrt{D} - GJ)/(1/\tan HKJ - 1/\tan AGI)$$

or

$$H = (\sqrt{D} - GJ)/(1/\tan HKJ - 1/\tan AGI)$$

whichever yields a value of C < B in diagram 15-A. Then, GH and JK are:

$$GH = H/\sin AGI$$

$$JK = H/\sin HKJ$$

The final task is to find the area GHTI. The procedure is outlined in Figure 15B, which corresponds to the figure bounded by GHTI in Figures 13 and 14. "Θ" corresponds to AGI, "ϕ" to AIG, and "d" to HT. To find HT, we employ the Law of sines:

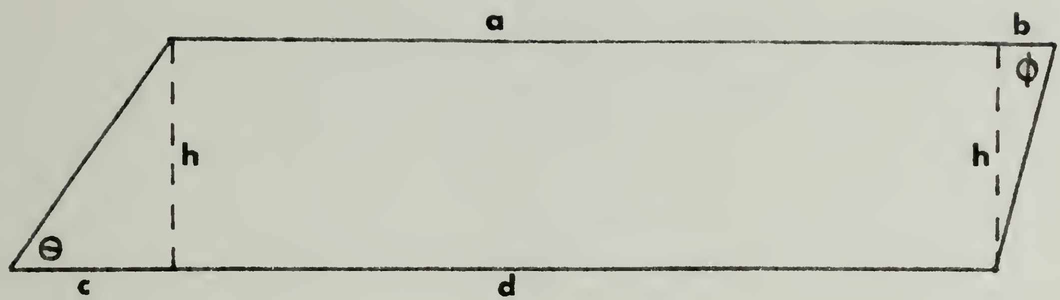
$$GAI = 180 - ACB$$

$$AIG = 180 - AGI - GAI$$

$$HT = (GA - GH) \sin GAI/\sin AIG$$

Now the area:

$$ARGHTI = (\tfrac{1}{2})(H)^2/\tan AGI + (HT)(H) + (\tfrac{1}{2})H^2/\tan AIG$$



$$\text{Area} = \tfrac{1}{2}ch + dh + \tfrac{1}{2}bh$$

$$c = h/\tan\theta$$

$$b = h/\tan\phi$$

Let $B = c + d$

Then $d = B - C = B - h/\tan\theta$

Also $a + b = d + b = B - h/\tan\theta + h/\tan\phi$

$$\text{Area} = \tfrac{1}{2}h^2/\tan\theta + Bh - h^2/\tan\theta$$

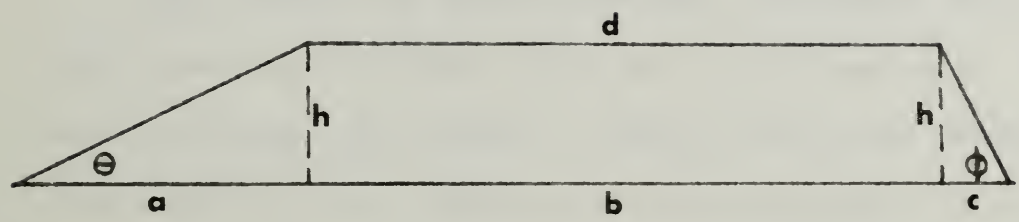
$$(1/(2\ \tan\phi) - 1/(2\ \tan\theta))h^2 + Bh - \text{Area} = 0$$

$$D = B^2 + 4(1/(2\ \tan\phi)) - 1/2\ \tan\phi))(\text{Area})$$

$$= B^2 + 2(\text{Area})(1/\tan\phi - 1/\tan\phi)$$

$$h = \frac{-B \pm \sqrt{D}}{(1/\tan\phi - 1/\tan\theta}$$

Figure 15a: Procedure for finding length correction



$$\text{Area} = \tfrac{1}{2}\,ah + bh + \tfrac{1}{2}ch$$

$$a = h/\tan\theta$$
$$c = h/\tan\phi$$
$$d = b$$

$$\text{Area} = \tfrac{1}{2}h^2/\tan\theta + dh + \tfrac{1}{2}h^2/\tan\phi$$

Figure 15b: Procedure for correcting cross-sectional areas

D9. Subroutine GRAFS

GRAFS is accessed by DLRLE to draw graphs of the dragline relationships:

1. Final Slope vs. Volume Graded

2. Final Slope vs. Total Cost

3. Final Slope vs. Final Width (Opening Cut)

or Final Slope vs. Cost/Acre (mine Run & Final Cut)

GRAFS divides the screen area into 4 quadrants, and places the three graphs in the first, third, and fourth quadrants. The second quadrant (upper left) issued to display the current values of the initial spoils grading data. GRAFS calls subroutine AXES to draw the axes for the graphs, and uses the entries in label common TABLE for the curve displayed. Subroutine DSPLA is called to display the current input data.

D10. Subroutine AXES

AXES is accessed by GRAFS to draw the axes for the draline realtionship graphs. The calling sequence is:

CALL AXES (IX, IY, XMIN)

where

IX is the absolute X screen coordinate of the graph's origin

IY is the absolute Y screen coordinate of the graph's origin

XMIN is the minimum X value to be displayed.

The algorithm is straightforward: First the X-axis, with tick marks, then the Y-axis with tick marks are drawn. Labels are appled where necessary.

D11. Subroutine DSPLA

DSPLA is accessed by GRAFS to display the current initial data in the upper left corner of the screen.

D12. Subroutine DLTDR

DLTOR is accessed by DLRLE to print the table of the dragline relationships. The calling sequence is:

CALL DLTDR (LUL, LUT, LER, ICUT)

where

LUL is the logical unit of the list device

LUT is the logical unit of the user's terminal

LER is .TRUE. for erase capability

ICUT is the current cut option (as defined by RGENDE(2) in CLAIM common)

DLTDR simply displays the values declared in label common TABLE on the list device specified by the user.

D13. Subroutine DLISP

DLISP is accessed by DLGE and DLDCS to allow user definition of the dragline slope/per cent pairs.

The calling sequence is:

CALL DLISP (PRCT, SLPE, NUMB)

where

PRCT is the percent array

SLPE is the slope array

NUMB is the number of slope/percent pairs entered

OLISP first determines what the minimum and maximum final slope values are by calling MNMXF.

These limits are displayed to the user along with a set of instuctions for imput. If MODE ≠ 4, (the user is not in the "GRADE SPOILS WITHOUT CURRENT LAND USE OPTION RESTRICTIONS), a set of "recommended" final slope values and the percentage of the area to be graded to those slope values are presented. These recommendations (see the CLAIM user's manual, Scott 1980) are not based on the current cut geometry; rather, they are based on a reasonable slope/percent mixture that could be applied to a mining site. That is, DLISP may "recommend" that 25% of the final area be graded to 5.7 degrees for the High Use alternative; however, the user may have defined an average slope of the area in excess of 5.7 degrees. In this case, the recommended value cannot be implemented. For MODE = 4, recommendations are not presented because the user is grading to some arbitrary (that is, not defined by CLAIM) post mining land use.

D14. Subroutine DLRSL

DLRSL is accessed by DLGE to input the recommended slop/percent mixtures for the dragline mine. Currently, this routine simply calls subroutine DLIOF for the opening and final cut options, or DLIRM for the mine run option. These routines have been orgainized under the DLRSL executive in anticipation of further developments in this area.

D15.Subroutine DLIOF

DLIOF is accessed by DLRSL to read the recommended final slope/ percent pairs for the opening and final cut situations for the dragline

mine from the file: DLRSOF. The system routine SPOLU is called to access the file. "EXIT" is set to -1 should the access fail.

D16. Subroutine DLIRM

DLIRM is accessed by DLRSL to read the recommended final slope/ percent pairs for the mine run option of a dragline mine from the file: DLRSPM. The system routine SPOLU is called to access the file. "EXIT" is set to -1 should the access fail.

D17. Subroutine DLDCS

DLDCS is accessed by DLGE to display the current slope/percent pairs and allow user modification to them. DLDCS first calls subroutine FIXSP to ensure that any values read in by DLRSL are logical. A table is then displayed on the user's terminal showing the current slope/ percent pairs, and the user is asked to specify which land use he wishes to modify. This step is repeated until the user is satisfied with the current slopes and percents. (Subroutine FIXLN is called to fill the array "LINE", where LINE corresponds to one line in the table.) A line printer copy of the table is offerred when the user is finished.

D18. Subroutine FIXSP

FIXSP is accessed by DLDCS to "fix" the default slope/percent pairs; that is, to adjust any slopes that do not meet the geometrical or "CLAIM" restrictions for the current land use option. The first step is to make sure that the final slopes do not exceed the initial slopes of the spoil banks. Should this occur, the final slope value is set equal

to the initial slope value. The second step is to make sure that "cropland" is a valid alternative CLAIM imposes the restriction that final slope values for cropland must not exceed 5.7 degrees. Therefore, if the general slope of the area exceeds 5.7 degrees, all slopes and percents associated with cropland are set to zero, and the cropland alternative is not analyzed. The third is step is to ensure that no final slope value is less then the general slope of the area. Should this occur, the slope value is set to the general slope of the area. The fourth step consists of combining percentages of adjacent equal slope values. That is, if pair #1 declares 2 final slope value of 5.7 degrees, and pair #2 also declares a final slope value of 5.7 degrees; the percentages associated with these pairs are added together to form one pair. Only adjacent equal slopes are considered. Finally, all embedded zero slope/percent pairs caused by step 4 above are elimintcd.

D19. Subroutine FIXLN

FIXLN is accessed by DLDCS and DCDSI to fix the line of output for the slope/percent table. The "fix" consists of converting the real numbers to a hollerith string so that "dashes" can be used to represent nul fields. The calling sequence is :

CALL FIXLN (SLOPE, PERCENT, NSPP, KPAIR, LINE)

where

SLOPE is the final slope array

PERCENT is the percent array

NSPP is the number of slop/percent paris array

KPAIR is the current slope/percent pair

LINE is the output line

After "LINE" if filled with blanks, subroutine CNVRT is called (to return the hollerith string "KVALUE" corresponding to the argument passed) for each slope and percent entry. The "LINE" elements are set equal to the appropriate "KVALUE" elements, and FIXLN returns.

D20. Subroutine CNVRT

CNVRT is accessed by FIXLN to convert a real value to a hollerith representation of that value. The calling sequence is:

CALL CNVRT (VALUE,KVALUE)

where

VALUE is the value to be converted

KVALUE is the charater string representation of "VALUE".

The local array "INDEX" contains the characters "0" through "9". "VALUE" digits are replaced with "INDEX" entries, and CNVRT returns.

D21. Subroutine DLST

DLST is accessed by DLGE to present a summary table of volumes, costs, and widths (or cost/acre) for the dragline cut options. DLST simply loops through DLGCO, DLGCM, or DLGCF for the opening cut, nine run, or final cut options, respectively, and prints the table on the list device.

E. Truck & Shovel Grading Executive - TSGE

TSGE is the truck and shovel grading executive. TSGE is accessed by subroutine GDE. Depending on the value of MODE, the following occurs: (See Figure 16).

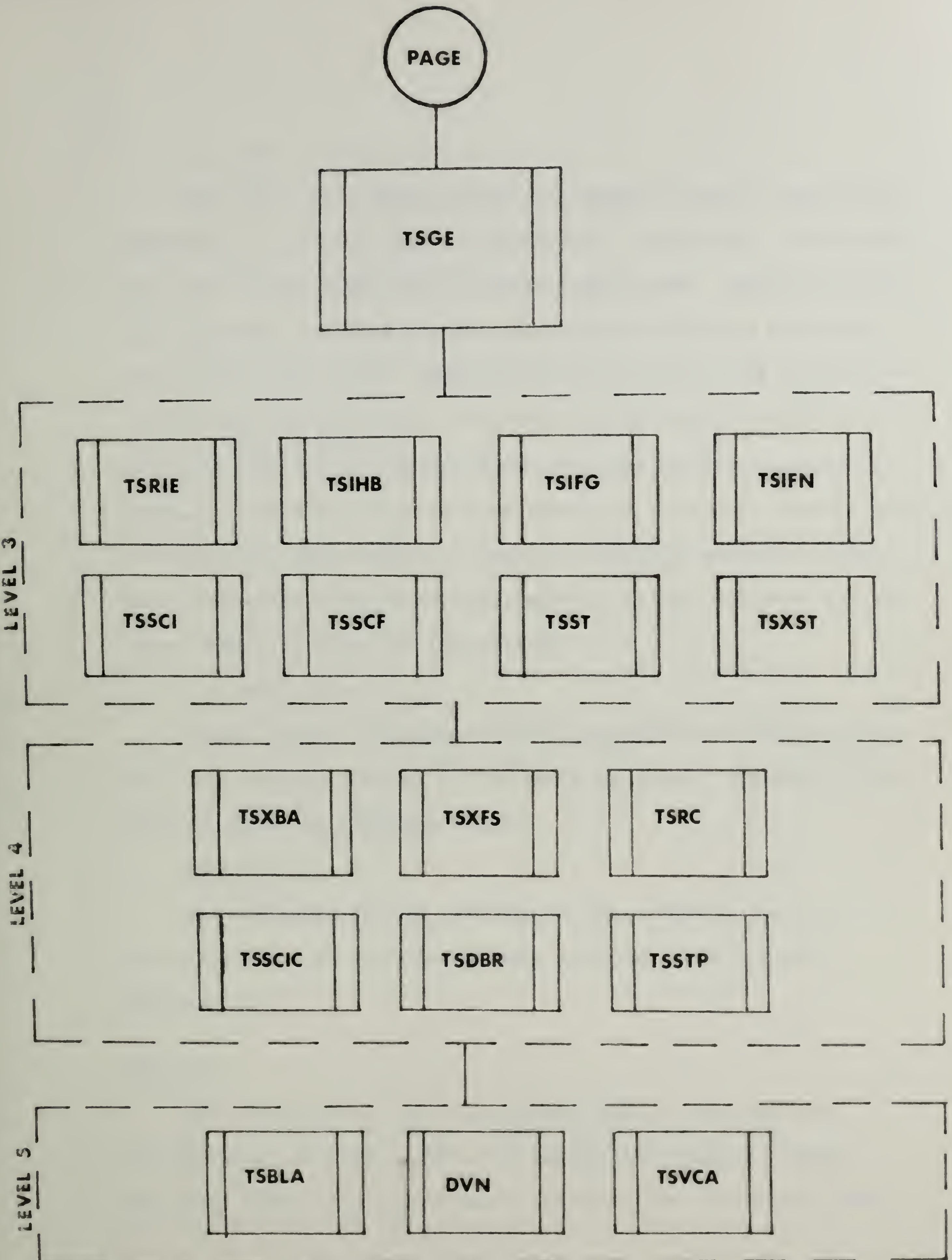


Figure 16. Truck and shovel grading modules.

---- MODE = 1 ----

TSGE first calls TSRIE to input the rehandle data for the mine run (RGENDE(2) = 2) or the final cut (RGENDE(2) = 3) options. IOPTN is set to 1 prior to the TSRIE call to indicate input mode. (MODE isn't used as an indicator in TSRIE since the user may edit rehandle data while still in the input mode.) Subroutine TSIHB is then called to input the initial highwall/bench data. (The user has the option, for LUO > 1, to enter the same initial highwall/bench data used in the previously described alternative.) The user may then elect to use the "graphic mode" to input final slope values, in which case TSIFG is scheduled; otherwise, subroutine TSIFN (non-graphic mode) is called. Options described under "MODE = 2" below are then offered.

---- MODE = 2 ----

Various options (described below) are presented to the user, and the local variable IPTR set to the user's selection. Depending on the value of IPTR, the following occurs:

IPTR = 0

The user wants to exit from this option. IOPTN is set to 2 and subroutine TSST is called to ensure current costs, and TSGE returns.

IPTR = 1

The user wants to view the summary table of volume and cost calculations. For LER = .TRUE., he may elect to inspect a cross-sectional view of the graded spoils, in which case, subroutine TSXST

is scheduled; or see the summary data only, in which case TSST is scheduled. TSGE then branches back to the option desplay. For LER = .FALSE., TSST only is scheduled.

IPTR = 2

The user wants to edit rehandle data. If it is not the opening cut option, IOPTN is set to 2, and TSRIE scheduled. TSGE then branches back to the option display.

IPTR = 3

The user wants to edit the spoil pile configuration code (SPCC). TSGE calls TSIHB and branches to the option display.

IPTR = 4

The user wants to schedule selective changes to the initial highwall/bench data. Subroutine TSSCI is called, and TSGE branches back to the option display.

IPTR = 5

The user wishes to schedule selective changes to the final slope values. Subroutine TSSCF is called, and TSGE branches back to the option display.

IPTR = 6

The user wishes to re-imput all initial highwall/bench data. TSGE branches back to the TSIHB call, and proceeds as described under MODE = 1.

IPTR = 7

The user wants to re-input all final slope values. TSGE branches to the user option allowing either a graphic or non-graphic mode and proceeds as described under MODE = 1.

---- MODE = 4 ----

This is the "grade spoils only" option. The procedure is identical to MODE = 1, except that no default slopes are offered, and the user cannot elect to use a previously described highwall/bench initial data set. TSGE uses LUO = 1 for this mode.

E1. Subroutine TSRIE

TSRIE inputs and edits the truck and shovel rehandle data. TSRIE is accessed by TSGE and uses the CLAIM common block. IOPTN is used as the mode indicator:

IOPTN = 1 → input mode

IOPTN = 2 → edit mode

Rehandle data consist of the following:

REHVOL : Rehandle volume in cubic yards

REHCPY : Rehandle cost in cents per cubic yard.

E2. Subroutine TSIHB

TSIHB is accessed by TSGE to input the initial highwall/bench data. Data input by TSIHB are:

HWHT : highwall height in feet

BENWI : initial bench width in feet

HWSLI : initial highwall slope in degrees

BENLEN : bench length in feet

SPCC : spoil pile configuration code.

The user is presented with the current data table when he is finished with the input, and may edit any of the entered data before exiting. Semi-circular spoils are adjusted by TSBLA if required.

E3. Subroutine TSBLA

TSBLA adjusts the bench lengths for semi-circular, truck and shovel produced spoils. TSBLA is accessed by subroutines TSIHB, TSIFN, TSXBA, and TSSCI. The calling sequence is:

CALL TSBLA (IPTR, ICHB, PARAM1, PARAM2)

where

IPTR = 1 → Adjust bench lengths based on a change in width of bench "ICHB"

= 2 → Adjust bench lengths based on a change in widths of bench "ICHB" and ICHB-1"

= 3 → Test for maximum and minimum bench lengths

= 4 → Adjust bench lengths based on a change in the initial highwall height

= 5 → Adjust bench lengths based on a change in the initial highwall slope

= 0 → TSBLA returns this value when at least one bench length required an adjustment

ICHB : Current highwall/bench pair (1 - NHBP(LUO))

PARAM1 : Depending on IPTR, this is:

IPTR = 1, 2 → PARAM1 is the new bench width for bench "ICHB"

IPTR = 4 → PARAM1 is the new highwall height for highwall "ICHB"

IPTR = 5 → PARAM1 is the new highwall slope for highwall "ICHB"

PARAM2 : The new bench width for bench "ICHB-1" (used only for IPTR = 2)

NOTE : ICHB, PARAM1, and PARAM2 are not used for IPTR = 3.

Figure 17-A on the next page shows the top view of a semi-circular, truck and shovel spoil pit comprised of three highwalls and benches (H/B). By "semi-circular," we mean that the H/B pairs form arcs of circles and are symmetric about the X, Y intercept axis shown in the diagram. We ensure that the angles defined by the length of the bench along the outside edge (BENLEN) and the distance from the origin (RBOE); hereafter referred to as the angles defined by the current data (ADBCD), are ordered such that:

$$\text{ADBCD}(1) \geq \text{ADBCD}(2) \geq \cdots \text{ADBCD}(\text{NHBP}(\text{LUO}))$$

(where NHBP(LUO) is the number of H/B pairs for the current land use option (LUO)), so that the upper highwalls are always graded onto the lower benches. Highwall one, of course, is graded onto the "ground."

After the user has described the initial H/B data, <u>the angles ADBCE are held constant*</u> for the remainder of the run. Therefore, any subsequent change in the bench width, the highwall height, or the initial highwall slope (Figure 17-B) will cause a change in the bench lengths.

TSBLA first determines the following:

1) The cross-sectional widths of the highwalls (XWIH).

$$\text{XWIH}(I) = \text{HWHT}(\text{LUO}, I)/\text{TAN}(\text{HWSLI}(\text{LUO}, I) * .01745)$$

for $I = 1, \text{NHBP}(\text{LUO})$

---

*The user may edit the bench lengths after describing the initial H/B pairs, and thus change the values in the ADBCD array, provided that his edit request is such that the ADBCD values meet the restriction discussed above. A legal edit, may, or course, result in a change in the bench bench.

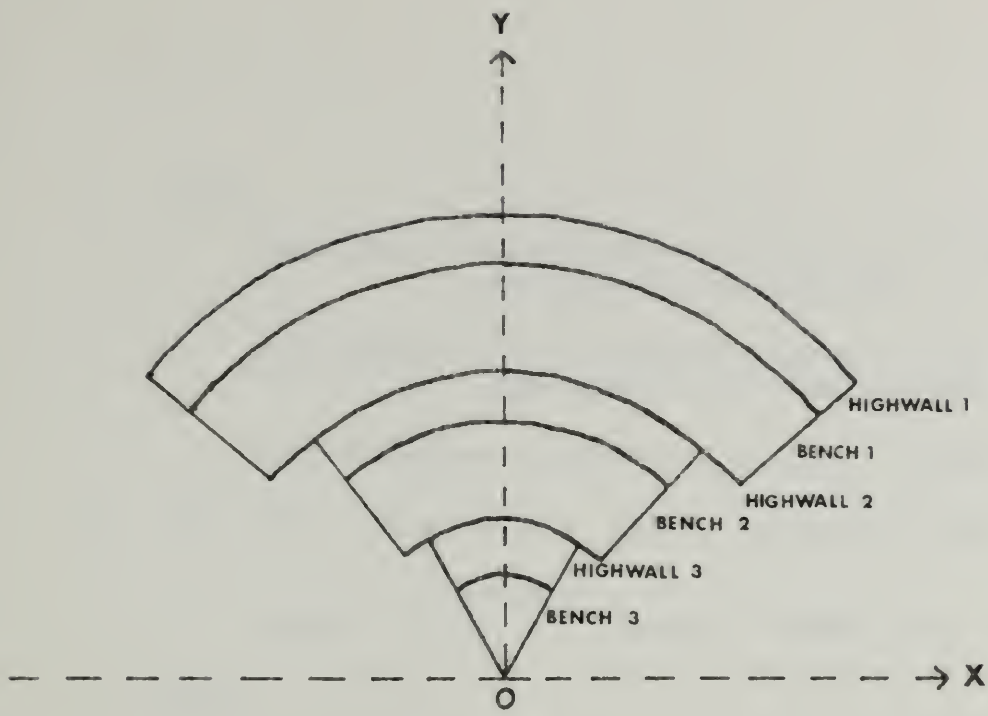


Figure 17-A. Top view of semi-circular (truck and shovel) produced spoils with three highwall/bench pairs

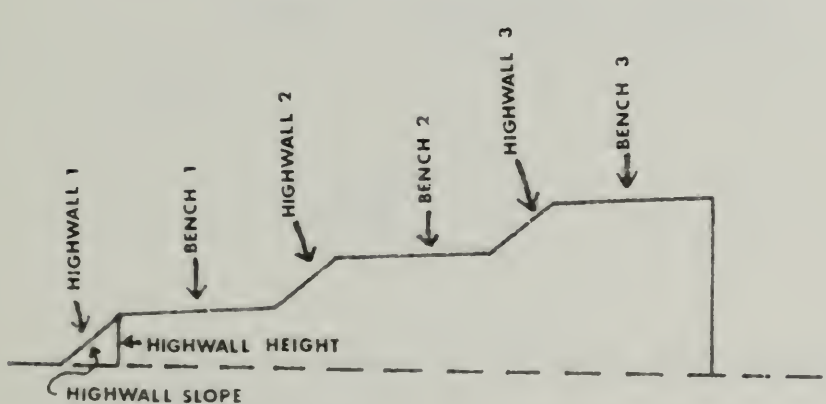


Figure 17-B. Cross-sectional view of truck and shovel produced spoils with three H/B pairs

where

HWHT(LUO, I) is the highwall height for highwall "I" and land use option "LUO"

HWSLI(LUO, I) is the initial highwall slope (degrees for highwall "I" and land use option "LUO"

.01745 converts degrees to radians. ($\pi/180 = .91745$)

2) The radii of the bench to the outside edge (RBOE)

$$RBOE(1) = \sum_{I=2}^{NHBP(LUO)} (XWIH(I) + BENWI\ (LUO,\ I)) + BENWI\ (LUO,\ 1)$$

where

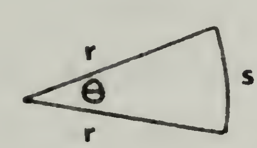
BENWI (LUO, I) is the initial bench width for bench "I" and land use option "LUO"

$$RBOE(I) = RBOE(I - 1) - BENWI\ (LUO,\ I-1) - XWIH(I);\ I = 2,\ NHBP(LUO)$$

3) If IPTR $\neq$ 3, TSBLA determines the angles defined by the current data (ADBCD):

$$ADBCD(I) = BENLEN(LUO,\ I)/RBOE(I)$$

since



$$s = r\ \theta \rightarrow \theta = s/r$$

4) TSBLA now checks the value of IPTR, and does the following:

IPTR = 1 or 2

Bench length adjustments are based on a change to bench ICHB. Note that a change in bench ICHB will affect the RBOE values, and thus the bench lengths, of each bench below ICHB, and, of course, the bench length for bench ICHB.

First, the RBOE values are changed according to:

a) RBOE (ICHB) = RBOE (ICHB) + PARAM1 - BENWI (LUO, ICHB)

If IPTR = 2,

b) RBOE (ICHB - 1) = RBOE (ICHB) + XWIH (ICHB) + PARAM2

The other radii are adjusted, then, by:

c) RBOE (I) = RBOE (I + 1) + XWIH (I + 1) + BENWI (LUO, I)

for I = 1, ICHB-1 (IPTR $\neq$ 2),

I = 1, ICHB - 2 (IPTR = 2)

<u>IPTR = 3</u>

Bench lengths are tested for maximum and minimum values. The maximum bench length (BLMAX) is, of course, given by

BLMAX = RBOE(I) * 6.28319 I = 1, NHBP(LUO)

where 6.28319 is 2 π (forming a full circle). Should a user input bench length exceed the maximum, that bench length is set to the maximum, and a message is printed informing the user of the adjustment. The minimum bench length (BLMIN) is dependent upon the angle defined by the upper bench, called the current minimum angle (CMA):

CMA = BENLEN(LUO, I+1)/RBOE(I+1)

for I = 1, NHBP(LUO) - 1

BLMIN = RBOE(I) * CMA

Should any bench length be less than BLMIN, its value is set to BLMIN, and a message displayed to the user. If any bench length required an adjustment, IPTR is set to zero, and TSBLA returns.

<u>IPTR = 4</u>

Bench length adjustments are based on a change in highwall "ICHB" height. This affects the variable XWIH:

XWIH(ICHB) = PARAM1/TAN(HWSLI(LUO,I) * .01745).

A change in XWIH(ICHB) affects the RBOE values, and thus the bench lengths, of all benches below ICHB, therefore, all RBOE values are adjusted as described under IPTR = 1 or 2, equation c.

IPTR = 5

Bench length adjustments are based on a change in the initial slope for highwall "ICHB." This affects the variable XWIH:

XWIH(ICHB) = HWHT(LUO, I)/TAN(PARAM1 * .01745).

RBOE values are adjusted as described under IPTR = 1 or 2, equation c.

5) For IPTR ≠ 3, TSBLA now adjusts the bench lengths, according to:

BENLEN(LUO, I) = RBOE(I) * ADBCD(I)

for I = 1, ICHB (IPTR = 1 or 2)

I = 1, ICHB-1 (IPTR = 4 or 5)

A message is displayed informing the user of the bench adjustments, and TSBLA returns.

E4. Subroutine TSIFG

TSIFG inputs final slopes desired on the highwalls using the graphic mode. TSIFG is scheduled by TSGE and uses CLAIM Swap Control via program TSIFX.

TSIFG first reads the recommended slope values from the file TSRFS. The minimum requestable final slope SLMIN is then determined by a call to TSSCK. The minimum requestable final slope depends on the height and slope of the highwall, the width of the bench above the current high-

wall, and the width of the bench below the current highwall. The lesser of these two benches is referred to as the limiting bench number. A cross-sectional view of the current minimum requestable slope is then drawn in the upper left corner of the screen. Subroutine DVN is used to display the numerical values of the current data. The user is then asked to input the final slope value desired on this highwall. If the user's slope request (USR) is less than the minimum slope request, subroutine TSXBA is scheduled to display (in the upper right hand corner of the screen), a cross-sectional view of bench adjustments necessary to implement USR. A returned value of IHB = 0 means that the user wants to exit; otherwise, SLMIN is recalculated (since the user may have edited either or both of the benches associated with this highwall), and the SLMIN cross-section is redrawn, and USR re-entered. Should USR be equal to or greater than SLMIN, TSIFG tests USR to verify that its value is less than the maximum permitted (SLMAX). The value of SLMAX is, for the CLAIM run (MODE $\neq$ 4), set to 5.7 degrees for LUO = 1, and 19 degrees for LUO > 1. For MODE = 4, SLMAX is set to the initial highwall slope (HWSLI). If USR is greater than SLMAX, an error message is displayed, and the user must re-enter USR. Otherwise, subroutine TSXFS is scheduled to display a cross-section of the final slope value. TSIFG loops through each highwall/bench pair in this manner until done, or the user indicates an exit in TSXBA. When an exit is initiated prior to describing the complete final highwall description, final slopes and bench widths are set to initial slopes and bench widths.

E5. Subroutive DVN

DVN is accessed by TSIFG, TSXFS, and TSXBA to draw "vector" numbers. A series of move commands are used to represent the number to be drawn in any of the 4 cardinal directions. The calling sequence is described in the program listing.

E6. Subroutine TSXBA

TSXBA displays a cross-sectional view of suggested bench adjustments needed to implement a user's slope request. TSXBA is scheduled by TSIFG and uses CLAIM Swap Control via program TSXBX.

TSXBA first determines the minimum bench width (BMIN) that will accomodate the user's slope request (USR) by calling subroutine TSDBR. TSXBA then tests the current bench widths to see if they exceed BMIN. If not, then either or both of the local variables ABWBA (the adjusted bench width of the bench above) and ABWBB (the adjusted bench width of the bench below) are set to BMIN, and a cross-sectional view labeling the necessary bench adjustment is displayed in the upper right hand corner of the screen. Subroutine DVN is used to label the user's slope request (USR). The user then has the option of:

(i) Implementing the suggested bench adjustments,

(ii) Re-inputting USR, or

(iii) Exiting from the final slope description option.

For option (iii), IHB is set to zero. Control is passed back to TSIFG.

E7. Subroutine TSXFS

TSXFS displays a cross-sectional view of the final slope for the current highwall. TSXFS is scheduled by TSIFG and uses CLAIM Swap Control via TSXFX.

The cross-section is displayed in the upper right hand corner of the screen. Subroutine DVN is used to display the values of the final slope value, the initial slope value, and both terraces.

E8. Subroutine TSIFN

TSIFN inputs the final slopes desired on the highwalls for the truck and shovel type mine using the "non-graphic" mode. By non-graphic, we mean that input text may be displayed on any standard teletype unit. TSIFN is scheduled by TSGE and uses CLAIM Swap Control via TSIFØ.

TSIFN first reads the recommended final slope values from the file TSRFS, then displays these values to the user. The user has the option of using these values (IDFALT = 1), or inputting his own (IDFALT = 2). In either case, TSIFN tests the final slope value by calling TSSCK, in the same manner as described in TSIFG. Should the user's slope request (either the default value or the user's input value) be less than the minimum requestable slope, the user has the option of re-inputting USR or obtaining a suggestion that will enable him to use USR. In the latter case, TSIFN calls TSDBR to determine the minimum bench width that will accomodate USR, and displays the adjustment to either or both of the benches adjoining the highwall. Should the user elect to use the bench

adjustments, TSRC is called to recalculate final terrace widths based on the newly defined initial bench widths and TSBLA scheduled to adjust bench lengths. The loop continues until all final slopes desired on the highwalls are defined, or the user indicates an exit. When an exit is initiated, final slopes and bench widths are set to initial slopes and bench widths before returning.

E9. Subroutine TSRC

TSRC recalculates final bench widths for a mid-stream change in initial data. TSRC is scheduled by TSIFN and uses the arguments:

LUO : land use option reference number

NUMBR : current highwall/bench pair number

HWSLI : initial highwall slope array

HWHT : highwall height array

HWSLF : final highwall slope array

BENWF : final bench width array

BENWI : initial bench width array

TSRC first sets all final bench widths to initial bench widths, then loops through TSDBR to adjust the final bench widths to their correct values.

E10. Subroutine TSSCI

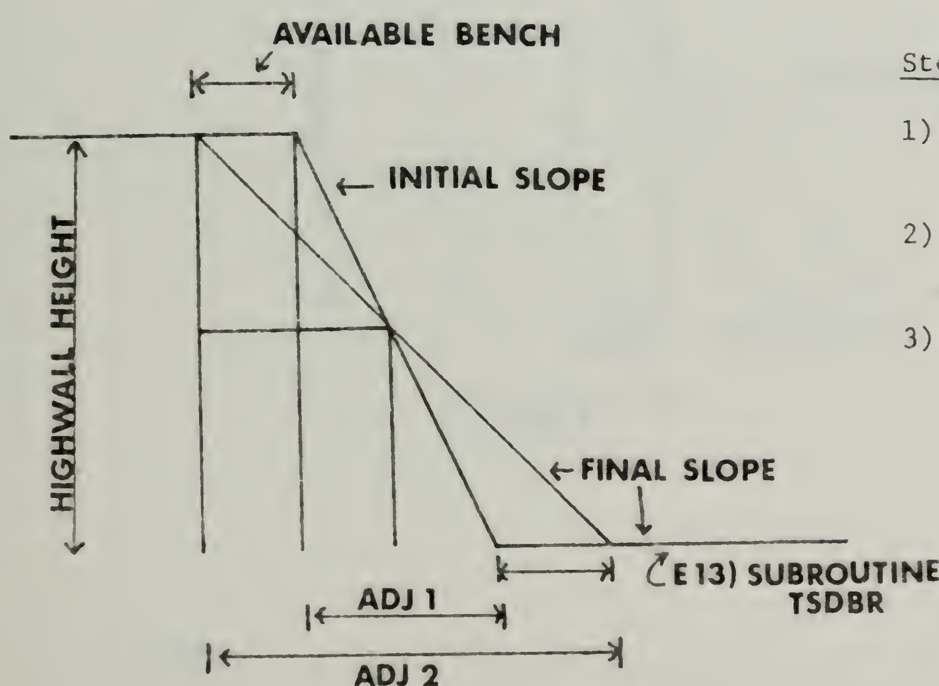
TSSCI is accessed by TSGE to allow selective changes to the initial input data. The user requested edit is tested against other input values to make sure it "fits." Legal edits are implemented and costs recomputed (by TSGE).

E11. Subroutine TSSCF

TSSCF is accessed by TSGE to allow selective changes for the final slope values. A user requested edit is tested against current parameters to see if it will "fit". The methodology is straight forward and well documented in the program listing.

E12. Subrontive TSSCK

This subroutine determines the minimum final desired slope requestable by the user, based on the initial slope of the highwall, the height of the highwall, and the available bench (see Figure 18).



Steps:

1) ADJ1 = Height/Tangent (initial slope)

2) ADJ2 = ADJ1 + (2 x Available bench)

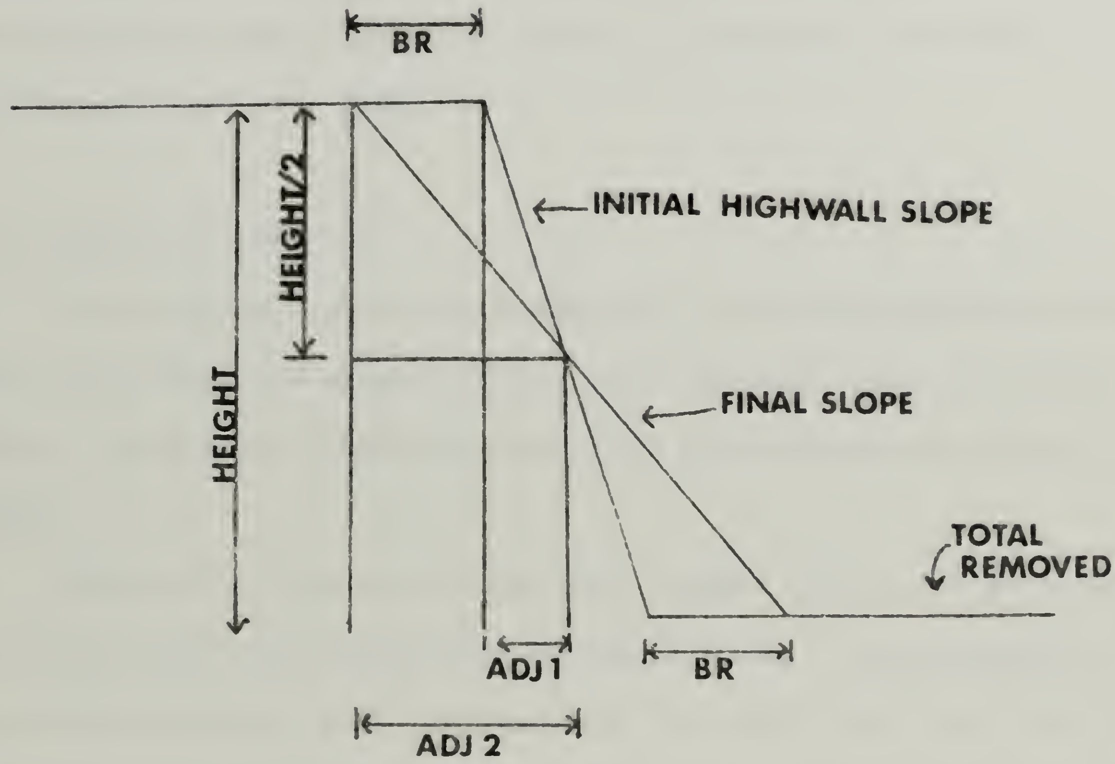
3) Minimum final slope = arctangent (HEIGHT/ADJ2)

Figure 18. Geometry of Minimum Final Slope Requestable.

The available bench is determined to be the lesser of the width of the bench below, or the width of the bench above.

E13. Subroutine TSDBR

TSDBR calculates the amount of Bench Removed based on initial slope, final slope, and highwall height (see Figure 19 below).



Steps:

1. ADJ1 = (HEIGHT/2)/tan (initial slope)

2. ADJ2 = (Height/2)/tan (final slope)

3. BR = ADJ2 - ADJ1 tan

Figure 19. Geometry for Calculating the Amount of Bench Removed.

E14 Subroutine TSST

TSST displays the summary table of volumes, costs, and areas for grading truck and shovel produced spoils on either the terminal or the line printer. TSST is scheduled by TSGE using CLAIM swap control through program TSSTX.

TSST schedules TSVCA to get the summary data, then presents the data in tabular form. Rehandle totals are determined and added to the grading cost per acre (GCPA).

E15. Subroutine TSXST

TSXST displays a cross-sectional view of the graded highwall/bench pairs and presents a summary table of the volumes, costs, and areas. TSXST is scheduled by TSGE and uses CLAIM swap control via program TSXSX.

TSXST first draws the initial data (dashed line), then superimposes the final data (solid line) over the initial data. Draw commands are stored in the arrays XIDT (initial data) and XFDT (final data) for the X-coordinates, and YIDT for the Y coordinates. Subroutine TSSTP is then scheduled to display the summary table. The user may elect to display the data on the CALCOMP plotter. If so, the user inputs the plot size, and the logical unit for the plotter (LUD) is set by the system routine GETLU; otherwise, we return.

E16. Subroutine TSSTP

TSSTP displays the summary data for the truck and shovel produced

spoils. TSSTP is scheduled by TSXST and uses CLAIM swap control via program TSSTØ.

TSSTP schedules TSVCA to get the summary data, then draws the table outline using PLOT-10 routines. The move commands are stored in the array ITCA. After the table outline is drawn, the data from TSVCA are displayed. Rehandle costs are determined, and added to the grading cost per acre (GCPA).

E17. Subroutine TSVCA

Subroutine TSVCA computes volumes, costs, and areas for grading truck and shovel produced spoils. TSVCA is accessed by TSST and TSSTP and uses both the CLAIM common block and the arguments:

- VOL - volume array
- CST - cost array
- TOTVOL - total volume graded
- TOTCST - total cost of grading

The calling sequence is:

```
CALL TSVCA (VOL, CST, TOTVOL, TOTCST)
```

TSVCA recognizes two spoil configurations: semi-circular (SPCC = 1) and rectangular (SPCC = 2). By "semi-circular," we mean that the individual highwalls and benches form arcs of circles about a common origin, and are symmetric with respect to that origin. Reference is made to Figure 20 for both configurations, and Figure 21A (SPCC = 1) or Figure 21b (SPCC = 2). All variable names used in the subroutine correspond to these diagrams.

TSVCA determines the following:

(i) The final area covered by the spoils.

(ii) A volume array containing volumes graded on each highwall, a cost array containing costs for grading each highwall, and the total volume and cost for grading.

(iii) The percentage of the final area equal to 19 degrees.

TSVCA first determines the arrays BD, AE, and AB:

$$BD_I = GD_I/\tan(AGBD)$$

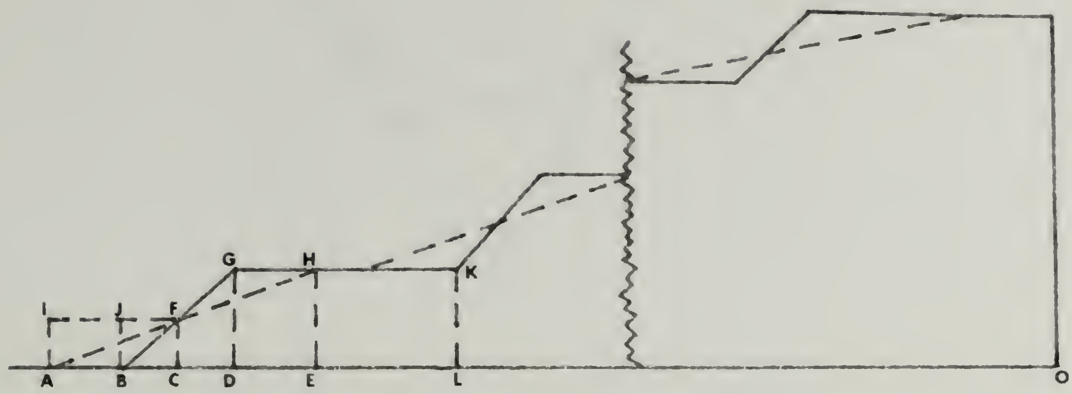
$$AE_I = GD_I/\tan(AHAD)$$

$$AB_I = (AE_I - BD_I)/2$$

Items (i), (ii), and (iii) will now be discussed in turn:

(i) Final Area

The area covered by the graded spoils will be the summation of the individual highwall/bench pair areas, plus the area contributed by grading highwall #1. (Highwalls above 1 are graded onto the benches below and therefore do not increase the acreage.)



Terms used

AB → Lower highwall width increase due to grading

AC → Lower highwall

AE → Cross-sectional width of the final highwall

BD → Cross-sectional width of the initial highwall

GD → Highwall height

DL → Initial Bench width

OL → Inner radius of highwall/bench (initial)

OD → Radius of bench along the outside edge

OC → Inner radius of lower highwall/bench

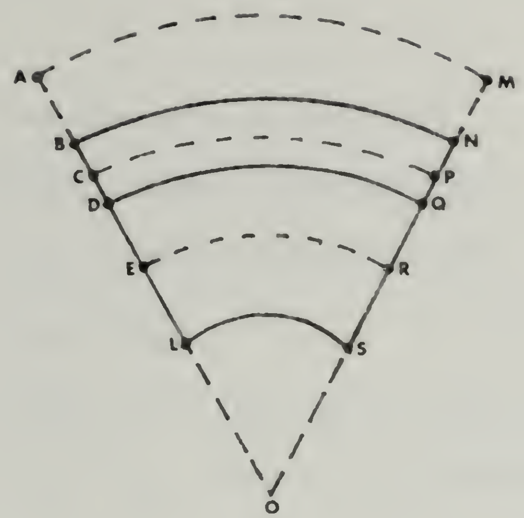
OB → Outer radius of highwall/bench (initial)

OA → Outer radius of highwall/bench (final)

GBD → Initial highwall slope (HWSL2)

HAD → Final highwall slope (HWSLF)

Figure 20. Cross-sectional View of Highwall/Bench pairs.



AM : Outer arc length (final)

BN : Outer arc length (initial)

DQ : Length of bench along the outside edge

CP : Inner arc length of lower highwall

LS : Inner arc length (initial)

ADOQ : Angle defined by bench length

AMPC : Base area of lower highwall

Figure 21A. Top view of semi-circular bench I

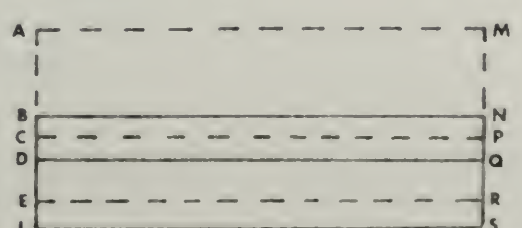


Figure 21B. Top view of rectangular bench "I".

For SPCC = 1, the area AMLS is given by:

$$A_{BON} = 1/2(OB)^2\ (ADOQ) = 1/2(OB)\ (BN)$$

$$A_{LOS} = 1/2(OL)^2\ (ADOQ) = 1/2(OL)\ (LS)$$

$$A_{BNSL} = A_{BON} - A_{LOS}$$

First, we determine the outer (OB) and inner (OL) radii of the initial H/B pairs. We set $OB_1 = OA_1$, since we are interested in the final area:

$$OB_1 = OA_1 = \sum_{I=1}^{N} (BD_I + DL_I) + AB_1$$

$$OL_1 = OB_1 - BD_1 - DL_1 - AB_1$$

For $I > 1$:

$$OB_I = OL_{I-1}$$

$$OL_I = OB_I - BD_I - DL_I$$

Next, we determine the radius of the bench along the outside edge (OD), the angle defined by this bench length (ADOQ), and the outer (BN) and inner (LS) initial arc lengths (Note that $BN_1 = AM_1$):

$$OD_I = OL_I + DL_I$$

$$ADOQ_I = DQ_I/OD_I$$

$$BN_I = (OB_I)(ADOQ_I)$$

$$LS_I = (OL_I)(ADOQ_I)$$

Now, we determine AREA:

$$AREA = \sum_{I=1}^{N} [((OB_I)(BN_I) - (OL_I)(LS_I))/2]$$

For SPCC = 2, the area of BNSL is simply:

$$A_{BNSL} = (BL)(BN) = (BD + DL)(DQ)$$

Then,

$$AREA = \sum_{I=1}^{N} [(BD_I + DL_I)(DQ_I)] + (AB_1)(DQ_1)$$

For both SPCC = 1 and SPCC = 2, the area is converted from square feet to acres by dividing by 43560.

(ii) Volume and Cost Arrays, and Totals

The method here is to find the volume of AIFC (Figure 20) and divide by 2 to obtain the volume of FAC. Next the volume of BJFC is divided by 2 to obtain the volume of FBC. Volume FBC is then subtracted from volume FAC to obtain the volume graded. Volumes are determined by finding the base areas and multiplying by one-half the highwall height. We first find the area of AMPC (Figure 21A):

<u>SPCC = 1</u>

First find OA, OC, AM, and CP :

$$OA_1 = OB_1$$

$$OA_I = OB_I + AB_I \qquad \text{For } I > 1$$

$$OC_I = OA_I - AE_I/2$$

$$AM_I = (OA_I)(ADOQ_I)$$

$$CP_I = (OC_I)(ADOQ_I)$$

Then,

$$AMPC_I = [(OA_I)(AM_I) - (OC_I)(CP_I)]/2$$

SPCC = 2

AMPC is found directly by:

$$AMPC_I = (AE_I/2)(DQ_I)$$

The volume (VOL) of FAC for both SPCC = 1 and SPCC = 2, is then

$$VOL_I = (AMPC_I)(GD_I)/4.$$

For SPCC = 1, the volume (VOLS) of FBCT is found by:

$$\text{Set} \quad OB_1 = OB_1 - AB_1$$

Then,

$$VOLS_I = [((OB_I)(BN_I) - (OC_I)(CP_I))/2][GD_I/2]/2$$

For SPCC = 2,

$$VOLS_I = [(BD_I/2)(DQ_I)][GD_I/4]$$

Then, the volume graded (VOL) is:

$$VOL_I = VOL_I - VOLS_I$$

The volume is converted from cubic feet to cubic yards by dividing by 27.

The cost array is found by multiplying the volumes by COGO:

$$CST_I = (VOL_I)(COGO)/100.$$

(We divide by 100 to convert from cents to dollars.)

Total cost and total volume are found by summing up the volume and cost arrays, and cost/acre by dividing the total cost by the area:

$$TOTVOL = \sum_{I=1}^{N} VOL_I \quad ; \quad TOTCST = \sum_{I=1}^{N} CST_I$$

$$GCPA = TOTCST/AREA$$

(iii) Percent of the area equal to 19 degrees

Here, we loop through the final slopes to find the HWSLF values equal to 19 degrees. The area of the HWSLF value = 19 degrees is

$$A_{HWSLF} = 19 = 2(AMPC_{I_{HWSLF = 19}})$$

The percentage is the sum of the $A_{HWSLF = 19}$ divided by the total area.

SECTION IV: ENVIRONMENTAL DATA

A. INTRODUCTION

By the term "environmental data" we are referring to that information described in categories 2-10 in the CLAIM User's Databook. Two methods of entering the environmental data are available: full display and abbreviated display. Full display presents all headings and subheadings within each category, along with the expectation of success values associated with each subheading. Abbreviated display presents the headings only. A schematic illustrating the routines scheduled in this segment is presented in Figure 22.

B. ABBREVIATED DISPLAY

Abbreviated display is scheduled through subroutine EIAD. For MODE = 1, EIAD jumps to the subroutine indicated by the EXIT pointer, and continues to schedule subroutines as shown in Figure 22, either until the value EXIT = 0 is returned, or until the last subroutine (CAT10) has been scheduled. Other values of MODE are not recognized in EIAD.

SUBROUTINES CAT2, CAT3, CAT4, CAT5, CAT6, CAT7, CAT8, CAT9, CAT10:

These subroutines input the responses for Categories 2-10, respectively. Headings only are presented. Each routine jumps to the heading indicated by the LEXIT pointer, and proceeds in stepwise fashion through each heading:

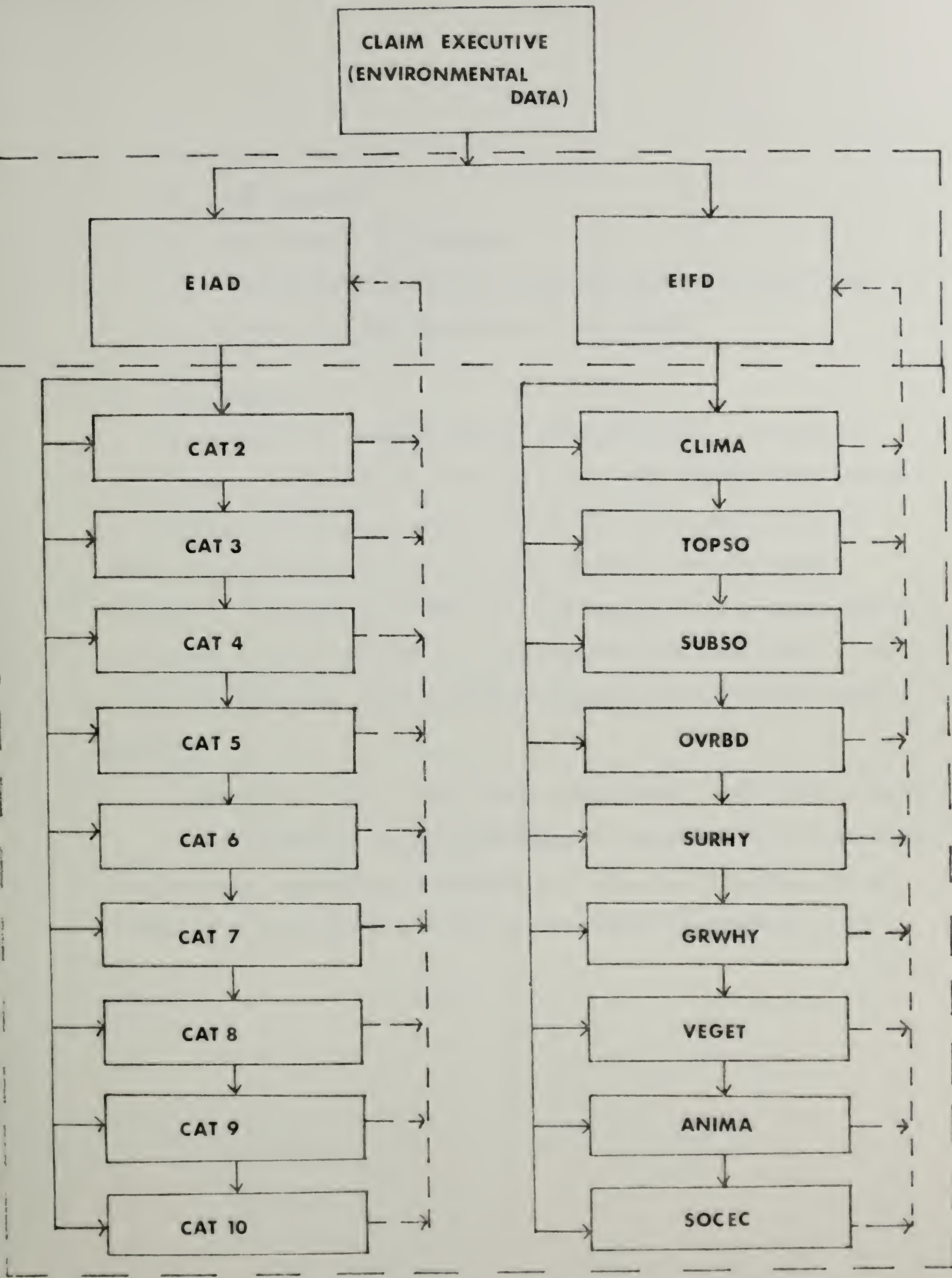


Figure 22. Environmental Data Module.

1) Display heading

2) Read response

3) Test response for validity

4) Display next heading, etc. until all headings have been completed, or a zero response has been entered.

C. FULL DISPLAY

Full display is scheduled through subroutine EIFD. For MODE = 1, EIFD jumps to the subroutine indicated by the EXIT pointer, and continues to schedule subroutines as shown in Figure 23, either until the value EXIT = 0 is returned, or until the last subroutine (SOCEC) has been scheduled. For MODE = 2 or MODE = 3, EIFD asks the user for the category he wishes to edit, sets EXIT to the appropriate value, and jumps to the indicated subroutine. This process is continued until the user requests an exit.

SUBROUTINES CLIMA, TOPSO, SUBSO, OVRBD, SURHY, GRWHY, VEGET, ANIMA, SOCEC:

These subroutines input the responses to Categories 2-10, respectively. All headings, subheadings, and expectation values are displayed during input. The flow diagram in Figure 23 illustrates the procedure used:

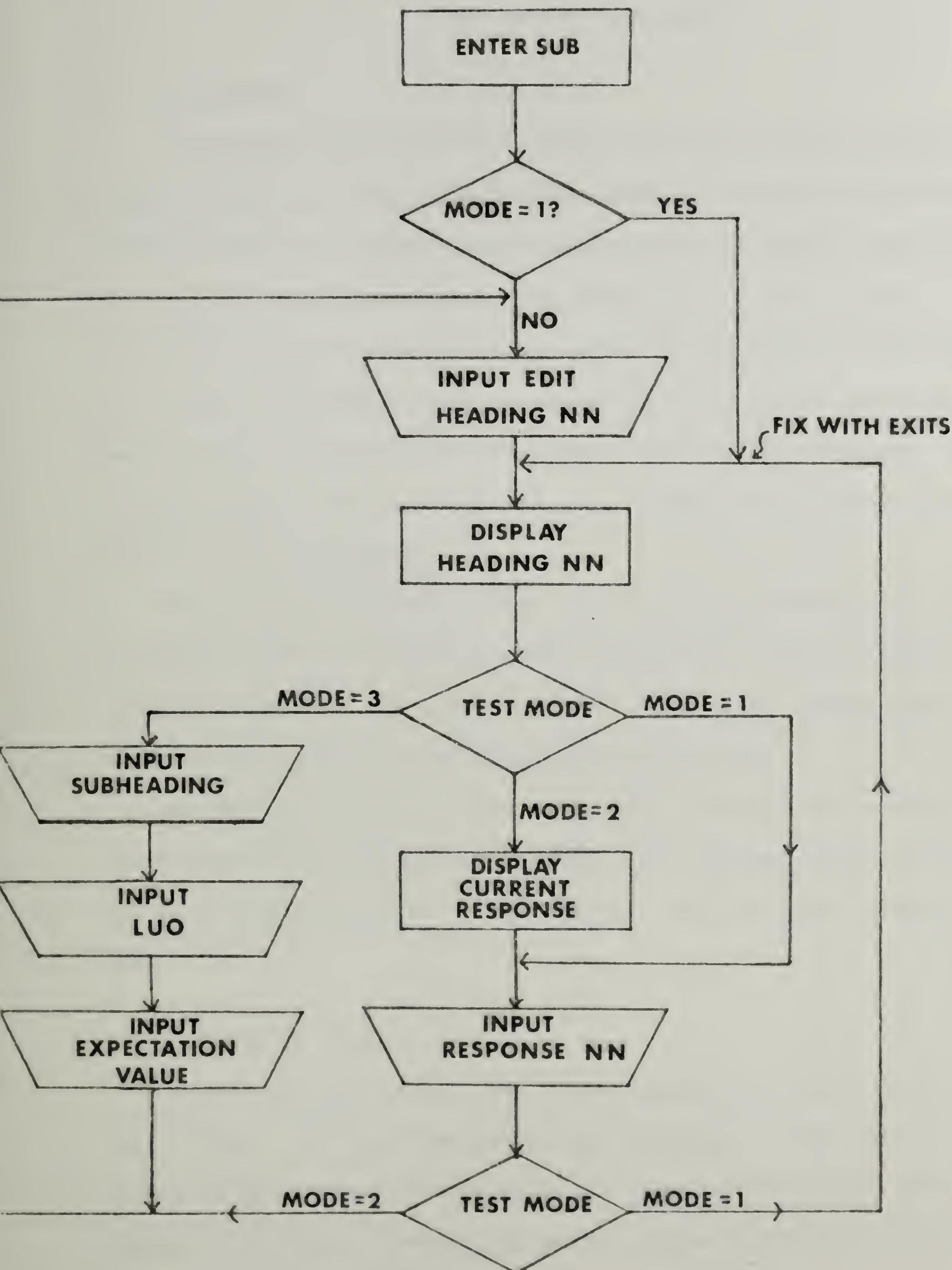


Figure 23. Full Display Method

SECTION V: DATA REVIEW

A. RESPONSES

Subroutines DCDS1 and DCDS2 display the current CLAIM data set for categories 1-5 and 6-10, respectively. DCDS1 and DCDS2 are both scheduled through CLAIM swap control using programs DCDSX and DCDSØ, respectively. The data are displayed on either the terminal or the line printer. For line printer display, the output is spooled by the system routine OTSPL. The categories, headings, and the subheading text, as well as the expectations values associated with the users responses are displayed. For terminal display, the user may exit at any stage. Line printer spools must be killed externally.

Since the text associated with any individual subheading may vary in length, the local variables STARTn and STOPn are used as pointers to indicate how much of the text array is to be printed. IPLACE keeps track of the location in the expectations value array.

An additional page of output is provided showing the overburden contribution to the feasibility ranking. The weighted overburden values are determined as described in SECTION VII: Data Analysis, Heading A: FEASI.

B. EXPECTATION VALUES

Subroutine DECV displays the current expectation values on the line printer. DCEV is scheduled through CLAIM swap control using program DCEVX. Output is spooled by the system routine OTSPL. DCEV displays the category number, the heading letter (IALPH array), and all expectation values associated with them.

SECTION VI: DATA STORAGE

A. INTRODUCTION

The Data Storage routine stores the user's data in a user-named file. All data files are stored on a storage cartridge and are identified by the following characters in the first word of the file's ID segment:

$* : General Description Parameters

#* : Environmental Data

** : Entire CLAIM data set.

Data Storage is scheduled through subroutine SRCD.

B. DATA STORAGE ROUTINE--SRCD

Subroutine SRCD stores and retrieves CLAIM data. SRCD is scheduled through CLAIM swap control via program SRCDX. The pointer IOPTN is set to 1 for file retrieval, and to 2 for file storage. The pointer IPNTR is set to 1 for general description parameters, 2 for environmental data, and 3 for the entire CLAIM data set. The system routine SPOLU is used for all reads and writes to FILID, the user input file name. FILID(1) is set according to IPNTR, as described above. The user first inputs the file name. If he is retrieving data, and the file doesn't exist, an error message is printed, and he must re-input the file name. If he is storing data, and the file already exist, he is given the option of writing over the existing file, or re-inputing the file name. For IARRY(2) = 3, the variable CSTES, CSTRM, CSTRP, and RTOPSO(1) are not stored or read. (IARRY(2) = 3 means that SRCD is being scheduled through SEAMPLAN.)

SECTION VII: DATA ANALYSIS

A. INTRODUCTION

The environmental feasibility rankings, techniques and economics analysis, and optimum use factors are discussed in this section (see Figure 24). The environmental feasibility rankings are determined by averaging the expectation of success values associated with the user's responses, and is scheduled through subroutine FEASI. The techniques and economics analysis evaluates the user's input data to develop a list describing the techniques and cost per acre for each technique to reclaim the mine site to the five land use options, and is scheduled through subroutine TECON. Optimum use factors combine both the feasibility rankings, and the total cost per acre for reclaiming to determine the optimum land use, and is scheduled by subroutine OPUSE.

B. ENVIRONMENTAL FEASIBILITY (FEASI)

Subroutine FEASI determines the feasibility averages for the current data. FEASI is scheduled through CLAIM swap control via program FEASX. FEASI outputs the ranking, in descending order.

FEASI first loops through each category and stores the total expectation of success values associated with each response in the array ITOTAL(I). Category V, (Overburden) does not make any contribution to the ITOTAL array during the first loop. Rather, a weighted average using the thickness of each overburden layer is determined by:

$$OAVG = \sum_{I=1}^{NU} (T_I * E_I) / \sum_{I=1}^{NU} (T_I)$$

where OAVG is the overburden average, T_I is the thickness of lithologic unit I, E_I is the expectation of success value for the response, and NU

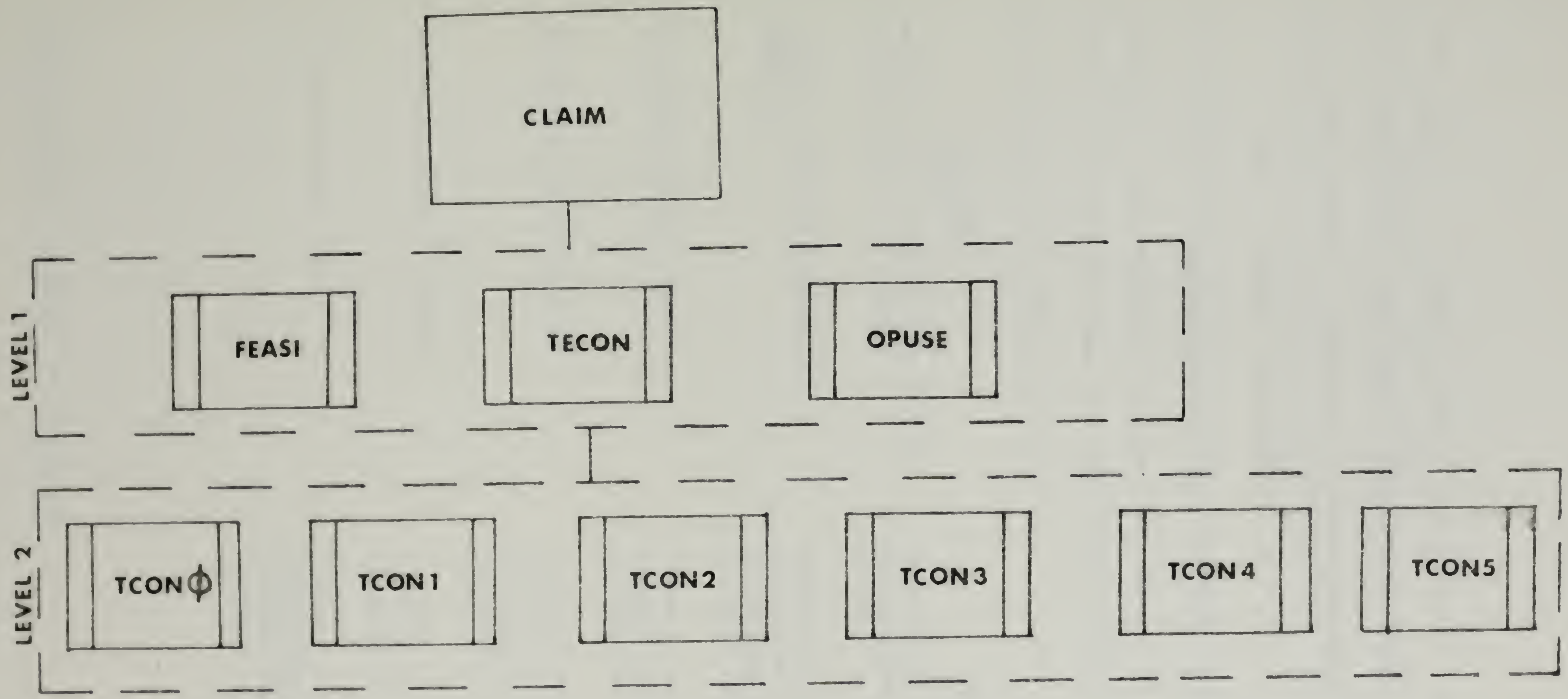


Figure 24. Data Analysis Module

is the number of lithologic units. The array TOC contains the total overburden contribution, and this is added to the ITOTAL value, then divided by the total number of responses to obtain the feasibility rankings:

AVGR = (ITOTAL + TOC)/NRES

where AVGR is the feasibility average, and NRES is the number of responses. The feasibility averages are then output in descending order. Messages are displayed when the appropriate response has been entered, as described in the following table:

RESPONSE	MESSAGE
Average slope of 10 random points in the area > 5.7 degrees	This general slope exceeds the maximum required by this model for the cropland reclamation alternative
Topsoil salinity exceeds 16 mmhos/cm	Present environmental and/or legal constraints prevent reclaiming to the cropland use option unless specific remedial actions are taken
Prime Agricultural Land	Present laws indicate that you must reclaim to the cropland alternative, regardless of the feasibility ranking
Endangered Plant Species	Present laws indicate that you must reclaim to the native vegitation alternative, regardless of the feasibility ranking
Endangered Animal Species	Present laws indicate that you must reclaim to the wildlife alternative, regardless of the feasibility ranking
Alluvial Valley Floor	Present environmental and/or legal constraints prevent reclaiming to the high use alternative unless specific remedial actions are taken

---

All appropriate messages are displayed.

C. TECHNIQUES AND ECONOMICS ANALYSIS

Subroutine TECON determines the techniques and economics list for the five land use options. TECON is scheduled through CLAIM swap control via program TECOX. The general procedure is to loop through the five land use options and determine the total cost for the alternatives. These costs are ranked, from least expensive to most expensive, and the loop re-entered to dump out the list. Each list provides all necessary techniques, and the cost per acre to implement each technique. The techniques are presented in the chronological order in which the reclamation engineer would normally apply each technique. The environmental parameters required to implement a technique, and the formulas used to compute the cost are described below. Three conversion factors are defined to convert the costs to dollars per acre values:

CF1 = (43560 square feet/acre);(27 cubic feet/cubic yard);
(100 cents/dollar)

CF2 = 2(CF1)

CF3 = CF1/12 inches/foot

Each cost per acre value is stored in the array EXPENS, and the order in which the list is to be presented is stored in the array IORDER.

A1, A2 - Strip/Respread all Topsoil

When subroutine TCON1 returns an ICHECK value of zero, these two techniques are implemented. The costs are:

$$\mathrm{EXPENS}_{\mathrm{STRIP}} = (\mathrm{CSTRM})(\mathrm{THKTS})(\mathrm{CF3})$$

$$\mathrm{EXPENS}_{\mathrm{RESPREAD}} = (\mathrm{CSTRP})(\mathrm{THKTS})(\mathrm{CF3})$$

B1, B2 - Strip/Respread One Foot of Subsoil

When subroutine TCON1 returns an ICHECK value of zero, and TCON4 returns an ICHECK value of zero, and the thickness of the topsoil layer is less than 24 inches, these two techniques are implemented. The costs are:

$$EXPENS_{STRIP} = (CSTRM)(CF1)$$

$$EXPENS_{RESPREAD} = (CSTRP)(CF1)$$

B3, B4 - Strip/Respread Two Feet of Subsoil

When TCON1 returns an ICHECK value of one, and TCON2 returns an ICHECK value of one, or when TCON1 returns an ICHECK value of zero, and TCON4 returns an ICHECK value of one, these two techniques are implemented. The costs are:

$$EXPENS_{STRIP} = (CSTRM)(CF2)$$

$$EXPENS_{RESPREAD} = (CSTRP)(CF2)$$

C1 - Rehandle Whole Layer

When subroutine TCON3 returns an ICHECK value of one, this technique is implemented. IWHERE contains those lithologic units that require rehandle. The costs are:

$$CARHL(I) = (CSTES)(THICK(IWHERE(I))(CF1) \qquad I \neq 0$$

EXPENS is the sum of the individual CARHL values.

C2 - Rehandle Two Feet of Seedbed Suitable Spoil

When TCON1 returns a value of zero, and TCON2 returns a value of zero, this technique is implemented. The cost is:

$$EXPENS = (CSTES)(CF2)$$

C3 - Grade Spoil

This technique is always listed, its cost has been previously determined:

EXPENS = GCPA

C4 - Rip 3-Foot Centers

When TCON3 returns an IRIP value of one, this technique is implemented:

EXPENS = CAR3FC

D1 - Chisel Plow

This technique is always listed, and the cost determined by:

Cropland, High Use Options: EXPENS = CACP

Native Vegetation, Wildlife, Water Recreation: EXPENS = CACP - CACP * PCEQ19

The variable ACACP is set to EXPENS for later reference.

D2 - Disc and Harrow

This technique is always implemented, and the cost determined by:

Cropland, High Use: EXPENS = CADH

Native Veg., Wildlife, Water Recreation: EXPENS = CADH - CADH * PCEQ19

The variable ACADH is set to EXPENS for later reference.

D3 - Chaining

This technique is implemented for the Native Vegetation, Wildlife, and Water Recreation options only. The costs are:

EXPENS = (CAC)(PCEQ19)

Should PCEQ19 be zero, this technique is not listed.

E1 - Buy Seed

This technique is always implemented. The cost is:

Cropland: EXPENS = CABS(1)

Native Vegetation, Wildlife, Water Recreation, High Use:
EXPENS = (CABS(2) - (CABS(2))(PCEQ 19) + (CABS(2))(2)(PCEQ19)

The variable ACABS is set to EXPENS for later reference.

E2 - Drill Seed

This technique is always implemented. The cost is:

Cropland, High Use: EXPENS = CADS

Native Vegetation, Wildlife, Water Recreation: EXPENS =
CADS - CADS(PCEQ19)

The variable ACADS is set to EXPENS for later reference.

E3 - Buy Fertilizer: Nitrogen (E3A), Phosphate (E3B)

These are always implemented, the cost is:

$EXPENS_{buy\ N}$ = CABFN(RTOPSO(8))

$EXPENS_{buy\ P}$ = CABFP(RTOPSO(9))

E4 - Drill Fertilizer

This technique is always implemented. The cost is:

Cropland, High Use: EXPENS = CABHM

Native Vegetation, Wildlife, Water Recreation: EXPENS =
CABHM - CABHM(PCEQ19)

The variable ACADF is set to EXPENS for later reference.

E5 - Buy Hay Mulch

This technique is always implemented. The cost is:

Cropland, High Use: EXPENS = CABHM

Native Vegetation, Water Recreation, Wildlife: EXPENS =
CABHM - CABHM(PCEQ19)

The variable ACABHM is set to EXPENS for later reference.

E6 - Apply Hay Mulch

This technique is always implemented. The cost is:

Cropland, High Use: EXPENS = CAAHM

Nat. Veg., Wildlife, Water Recreation: EXPENSE = CAAHM - CAAHM(PCEQ19)

The variable ACAAHM is set to EXPENS for later reference.

E7 - Hydromulch Seed and Fertilizer

This technique is implemented only for Native Vegetation, Wildlife, and Water Recreation. The cost is:

EXPENS = CAHSAF(PCEQ19)

If PCEQ19 is zero, this technique is not listed.

E8 - Hand Plant Shrub and Tree Seedlings

This technique is implemented for the Native Vegetation, Wildlife, Water Recreation, and High Use options (never for cropland). The cost is:

EXPENS = CAHSTS

F1 - Buy, Apply Herbicide

This technique is implemented for Cropland, Water Recreation, and High Use only. The cost is:

EXPENS = CABAH

The variable ACABAH is set to EXPENS for later reference.

F2 - Erect Animal Fencing

The conditions for implementation of this technique are:

Cropland, Wildlife, Water Recreation, High Use:

Big Game Mammals are present, or

Archaeologic sites are present, or

Upland birds and mammals are present or

Livestock grazing on adjoining lands.

Native Vegetation:

Any of the above, or if endangered plants are present.

The cost is:

EXPENSE = CAEAF

G1 - Snow Fencing

This technique is implemented for all land uses if the average annual precipitation exceeds 20 inches, and for Cropland and Native Vegetation if the annual precipitation exceeds 15 inches. The cost is:

EXPENS = CASF

G2 - Seed Nurse Crop

This technique is implemented when the conditions for G1 are met, for Native Vegetation, Wildlife, and High Use. The cost is:

EXPENSE = CASNC

G3 - Irrigation Plantings

When TCON5 returns an ICHECK value of one, this technique is implemented. The cost is:

Cropland, High Use: EXPENS = CAIP

Nat. Vegetation, Wildlife, Water Recreation: EXPENS = CAIP + CAIP * PCEQ19

H1 - Stabilize topsoil storage pile

This technique is always implemented, the cost is:

EXPENS = (ACACP + ACADH + ACABS + ACADS + CABFN(RTOPSO(8)) + CABFP(RTOPSO(9)) + ACADF + ACABHM + ACAAHM + ACABAH) * PFSTSP/100.

I1 - Administration Costs

This cost is always listed.

$$EXPENS = (PFAC/100) * \Sigma\ EXPENS_{(to\ this\ point)}$$

Subroutine TCONØ

Subroutine TCONØ checks for mandatory or forbidden land use options. The array IFLCK is used such that:

IFLCK(1) = 1 When we are in the Dragline mine, final or opening cut options (Cropland, High Use forbidden)

IFLCK(2) = 1 When the slope of 10 random points exceeds 5.7 degrees (Cropland and High Use forbidden)

IFLCK(3) = 1 When endangered plant species are present (Native Vegetation mandatory)

IFLCK(4) = 1 When endangered animal species are present (Wildlife mandatory)

IFLCK(5) = 1 When prime agricultural land is present (Cropland mandatory)

IFLCK(6) = 1 When alluvium is present (Flag message for High Use option)

Subroutine TCON1

Subroutine TCON1 tests for those conditions that indicate the presence of a poor topsoil layer. ICHECK is set to one when the following conditions are present:

For <u>all</u> land use options:

Topsoil is less than 6 inches, or

Texture of topsoil is sandy or clay, or

Salinity exceeds 16.0 mmhos/cm, or

SAR exceeds 14.9 meq/L.

For Cropland, Native Vegetation, Wildlife, or Water Recreation:

Percent organic matter is less than .1, or

Salinity is greater than 8.0 mmhos/cm, or

SAR is greater than 9.9 meq/L.

For Cropland:

If topsoil texture is clay loam, or

Salinity exceeds 4.0 mmhos/cm.

Subroutine TCON2

TCON2 tests for those conditions that indicate a poor subsoil layer. ICHECK is set to one when the following conditions occur:

All Land Use Options:

Subsoil thickness is less than 24 inches, or

Texture is sandy or clay, or

Salinity exceeds 16 mmhos/cm, or

SAR exceeds 14.9 meq/L.

For Cropland if:

Texture is clay loam, or

Salinity exceeds 4.0 mmhos/cm, or

SAR exceeds 9.9 meq/L.

Subroutine TCON3

Subroutine TCON3 tests for toxic overburden layers that require rehandle. If no units require rehandle, ICHECK is set to zero, otherwise ICHECK is set to one, and the array IWHERE flagged for those units requiring rehandle. Rehandle is applied, for any unit exceeding 15 percent of the total thickness of overburden, for those units meeting the following conditions:

All Land Use Options:

Number of rocks in unit exceeds 1000, per acre, or

Salinity of unit exceeds 16 mmhos/cm, or

SAR exceeds 14.9 meq/L.

Cropland and Native Vegetation:

Salinity exceeds 8.0 mmhos/cm.

Cropland:

Number of rocks exceeds 100. per acre,

Also, for all land use options except High Use, layer number 1 is rehandled if alluvium is present.

TCON3 also tests for technique C4: rip 3-foot centers. IRIP is set to one if any lithologic unit greater than 15 percent of the total thickness has a bulk density greater than 1.5 for all options except high use.

Subroutine TCON4

Subroutine TCON4 tests for those conditions identifying a good subsoil layer when topsoil thickness is less than 24 inches. ICHECK is set to one when the following conditions exist:

Cropland:

Subsoil thickness exceeds 23.9 inches, and

Texture is sandy loam, loam, or silt loam, and

Salinity is less than 4.1 mmhos/cm, and

SAR is less than 10 meq/L.

Native Vegetation, Wildlife, Water Recreation, High Use

Subsoil thickness exceeds 23.9 inches, and

Texture is sandy loam, loam, silt loam, or clay loam, and

Salinity is less than 16.1 mmhos/cm, and

SAR is less than 15.0 meq/L.

Subroutine TCON5

TCON5 tests for those conditions that require the implementation of technique G3 - irrigate plantings. ICHECK is set to one for the following conditions:

Cropland:

Average annual precipitation is less than 15.1 inches, and

Amount of surplus surface water is greater than .25 acre feet/ per acre, and

Salinity of surface water is less than 751 mmhos/cm, and

SAR of surface water is less than 18.1 meq/L.

- or -

Amount of surplus groundwater is greater than .25 acre feet/ per acre, and

Salinity of groundwater is less than 751 mmhos/cm, and

SAR of groundwater is less than 18.1 meq/L.

Native Vegetation, Wildlife:

Average annual precipitation is less than 10.1 inches, and

Amount of surplus surface water is greater than .1 acre feet/ per acre, and

Salinity of surface water is less than 2251 mmhos/cm, and

SAR of surface water is less than 26.1 meq/L.

- or -

Amount of surplus groundwater is greater than .1 acre feet/ per acre, and

Salinity of groundwater is less than 2251 mmhos/cm, and

SAR of groundwater is less than 26.1 meq/L.

Water Recreation:

Average annual precipitation is less than 15.1 inches, and

Surplus surface water is greater than .5 acre feet/ per acre, and

Salinity of surface water is less than 2251 mmhos/cm, and

SAR is less than 18.1 meq/L.

- or -

Surplus groundwater is greater than .5 acre feet/acre, and

Salinity of groundwater is less than 2251 mmhos/cm, and

SAR of surface water is less than 18.1 meq/L.

High Use:

Average annual precipitation is less than 10.1 inches, and

Surplus surface water is greater than .1 acre feet/acre, and

Salinity of surface water is less than 2251 mmhos/cm, and

SAR of surface water is less than 26.1 meq/L.

- or -

Surplus ground water exceeds .1 acre feet/acre, and

Salinity of groundwater is less than 2251 mmhos/cm, and

SAR of groundwater is less than 26.1 meq/L, and

Alluvium is not present.

D. OPTIMUM USE ANALYSIS (OPUSE)

Subroutine OPUSE calculates the Optimum Use Factors. OPUSE is scheduled through CLAIM swap control via program OPUSX. The optimum use factors are determined by the following formula:

OPTM = FAVG * TCAR/1000

where

OPTM is the optimum use value,

FAVG is the feasibility average, and

TCAR is the total cost/acre to reclaim.

OPUSE uses the arrays AVGR and EKON to rank the feasibility averages (from largest to smallest) and the total cost for reclamation (from least to most expensive), and presents a summary table displaying all of these items.

Section VIII. Literature Cited

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Scott, M. D. 1980. CLAIM computerized reclamation planning system for Northern Great Plains surface coal mines. User's databook. USDA For. Serv. Intermountain For. Range Expt. Sta., Ogden, Utah. 23 p.

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Section IX. Appendices

Appendix A
CLAIM COMMON BLOCK

Part 1: Tektronix common

Variable Name	Type	Description	Units	Location
ITEK	Integer	Terminal Status Area needed for the PLOT-10 plotting package	----	Words 1 - 45

Note: ITEK contains the variables:
KBAUDR, KERROR, KGRAFL, KHOMEY, KLMRGN, KRMRGN,
KKMODE, KHORSZ, KVERSZ, KSIZEF, KDASHT
KBEAMX, KBEAMY, KMOVEF, KPCHAR(4),
KMINSX, KMINSY, KMAXSX, KMAXSY,
TMINVX, TMINVY, TMAXVX, TMAXVY, TRCOSF, TRSINF,
TRSCAL, TREALX, TREALY, TIMAGX, TIMAGY, KTABLT

KTABLT is a SEAMPLAN implemented variable for the digitizing tablet; otherwise, all variables are as described in the PLOT-10 Terminal Control System/User's Manual.

Part 2: Logical Units and Common Locations

Variable Name	Type	Description	Units	Location
IARRY	Integer	RMPAR buffer:		Words
		IARRY(1) = LUT = logical unit of the terminal	---	46 - 50
		IARRY(2) = Pointer, Ø = CLAIM run 3 = SEAMPLAN run	--- ---	
		IARRY(3) = logical unit of Calcomp plotter file	---	
		of Calcomp plotter file		
		IARRY(4), IARRY(5) - not used	---	
IARY2	Integer	RMPAR buffer: (common location)	---	Words 51 - 55
		IARY2(1) = ISTRK = starting track number		

Variable Name	Type	Description	Units	Location
(IARY2)		IARY2(2) = ISECT = starting sector number	---	
		IARY2(3) = ICODE = read/write code	---	
		IARY2(4) = LEN = length of common transfer > 6144 words	---	
		IARY2(5) - not used	---	
LER	integer	Logical variable set to .TRUE., for graphics capability	---	Word 56
LUF	integer	Logical unit for file reads/writes	---	Word 57
LUL	integer	Logical unit of list device	---	Word 58

Part 3: Pointers

Variable Name	Type	Description	Units	Location
EXIT	Integer	Category jump number, or zero to indicate an exit	---	Word 59
IANM	Integer	Number of subheadings/heading array for category IX: Animals	---	Words 60 - 62
ICLI	Integer	Number of subheadings/heading array for category II: Climatology	---	Words 63 - 64

Variable Name	Type	Description	Units	Location
IGEN	Integer	Number of subheadings/ heading array for category I: General Description	---	Words 65 - 67
IGRW	Integer	Number of subheadings/ heading for category VII: Ground Water Hydrology	---	Words 68 - 72
IOPTN	Integer	Pointer whose value and meaning varies between subroutines--generally used to either indicate a temporary input or edit mode, or to indicate the heading edit for general description parameters	---	Word 73
IOVR	Integer	Number of subheadings/ heading for Category V: Overburden	---	Words 74 - 80
IPNTR/IHB	Integer	Declared IHB for the truck & shovel mine to indicate the current highwall bench pair number, otherwise declared IPNTR, a pointer whose use varies among the subroutines	---	Word 81
ISOC	Integer	Number of subheadings/ heading for Category X: Socio-Economics	---	Words 82 - 87
ISUB	Integer	Number of subheadings/ heading for Category IV: Subsoil	---	Words 88 - 95
ISUR	Integer	Number of subheadings/ heading for Category VI: Surface Water Hydrology	---	Words 96 - 101

Variable Name	Type	Description	Units	Location
ITOP	Integer	Number of subheadings/ heading for category III: Topsoil	---	Words 102 - 110
IVEG	Integer	Number of subheadings/ heading for category IX: Vegetation	---	Word 111 - 112
LEXIT	Integer	Heading jump number	---	Word 113
LUO	Integer	Current Land Use Option: 1 - Cropland 2 - Native Vegetation 3 - Wildlife 4 - Water Recreation 5 - High Use 6 - Other	---	Word 114
MODE	Integer	Mode Indicator: 1 - Input mode 2 - Edit response mode 3 - Edit expectation mode 4 - Spoil grade mode	---	Word 115
NANM	Integer	Number of headings in category IX: Animals	---	Word 116
NCLI	Integer	Number of headings in category II: Climatology	---	Word 117
NGEN	Integer	Number of headings in category I: General Description	---	Word 118
NGRW	Integer	Number of headings in category VII: Ground Water Hydrology	---	Word 119

Variable Name	Type	Description	Units	Location
NOVR	Integer	Number of headings in category V: Overburden	---	Word 120
NSECTS	Integer	Number of categories (currently 10)	---	Word 121
NSOC	Integer	Number of headings in category X: Socio-Economics	---	Word 122
NSUB	Integer	Number of headings in Category IV: Subsoil	---	Word 123
NSUR	Integer	Number of headings in category VI: Surface Water Hydrology	---	Word 124
NTOP	Integer	Number of headings in category III: Topsoil	---	Word 125
NU	Integer	Number of lithologic units defined	---	Word 126
NVEG	Integer	Number of headings in category IX: Vegetation	---	Word 127

Part 4: Grading Parameters

Variable Name	Type	Description	Units	Location
AREA	Real	Area covered by graded spoils	Acres	Words 128 - 137
BENLEN	Real	Array containing bench lengths for truck and shovel spoils	Feet	Words 138 - 237

Variable Name	Type	Description	Units	Location
BENWI	Real	Array containing initial bench widths for truck and shovel spoils	Feet	Words 238 - 337
COGO	Real	Cost of grading spoils	cents/ cu. yd.	Words 338 - 339
GCPA	Real	Array containing the grading costs per acre	dollars/ acre	Words 340 - 349
GRDVBS/SPCC	Real	Declared SPCC for truck and shovel spoils: this is the spoil pile configuration code: 1 = semi-circular spoils 2 = rectangular spoils	---	Words 350 - 359
		Declared GRDVBS for dragline spoils. This is the grading variables array, the contents depend upon the cut option:		
		<u>Opening cut</u>:		
		GRDVBS(1) = Height of the spoil bank	Feet	
		GRDVBS(2) = Slope of the spoils	Degrees	
		GRDVBS(3) = Length of the spoil bank	Yards	
		GRDVBS(4) = Slope of the area	Degrees	
		GRDVBS(5) = not used	---	
		<u>Mine run</u>:		
		GRDVBS(1) = Distance between spoil peaks	Feet	
		GRDVBS(2) = Slope of the spoils	Degrees	
		GRDVBS(3) = Area covered by spoils	Acres	
		GRDVBS(4) = Slope of the area	Degrees	
		GRDVBS(5) = not used	---	

Variable Name	Type	Description	Units	Location
(GRDVBS/SPCC)		Final cut:		
		GRDVBS(1) = length of the pit	Feet	
		GRDVBS(2) = highwall height	Feet	
		GRDVBS(3) = spoil bank height	Feet	
		GRDVBS(4) = slope of highwall	Degrees	
		GRDVBS(5) = slope of spoil bank	Degrees	
HWHT	Real	Array containing the highwall heights for the truck and shovel spoils	Feet	Words 360 - 459
HWSLI	Real	Array containing the initial highwall slopes for the truck and shovel mine	Degrees	Words 460 - 559
NSPP/NHBP	Integer	Declared NSPP for the dragline mine. This contains the number of slope/percent pairs. Declared NHBP for the truck and shovel mine. This contains the number of highwall/bench pairs	---	Words 560 - 564
PCEQ19	Real	Percentage of the final area equal to 19 degrees	Fraction	Words 565 - 572
PERCNT/BENWF	Real	Declared PERCNT for the dragline mine--contains the percent of the area to be covered by a specified slope	Fraction	Words 573 - 672
		Declared BENWF for the truck and shovel mine--contains the final bench widths (terraces) on the spoils	Feet	

Variable Name	Type	Description	Units	Location
REHCPY	Real	Rehandle cost per cubic yard (truck and shovel mine)	cents/ cubic yd.	Words 673 - 682
REHVOL	Real	Rehandle volumes (truck and shovel mines)	cubic yards	Words 683 - 692
SLOPE/HWSLF	Real	Declared SLOPE for the dragline mine--contains final slopes desired on the spoil banks. Declared HWSLF for the truck and shovel mine--contains final slopes desired on the highwalls	Degrees	Words 693 - 792
WBP/USR	Real	Declared WBP for dragline mine (final cut)--this is the width of the bottom of the pit	Feet	Words 793 - 794
		Declared USR for truck and shovel mine--this is the user's final slope request	Degrees	

Part 5: Category Text (see CLAIM User's Data book)

Variable Name	Type	Description	Units	Location
ANIM	Integer	Text for category IX: Animals	---	Words 795 - 1093
CLMA	Integer	Text for category II: Climatology	---	Words 1094 - 1262

Variable Name	Type	Description	Units	Location
GDES	Integer	Text for Category I: General Description	---	Words 1263 - 1457
GWHY	Integer	Text for Category VII: Ground Water Hydrology	---	Words 1458 - 1743
OVBD	Integer	Text for Category V: Overburden	---	Words 1744 - 1886
SBSL	Integer	Text for Category IV: Subsoil	---	Words 1887 - 1899
SCEC	Integer	Text for Category X: Socio-Economics	---	Words 1900 - 2328
SWHY	Integer	Text for Category VI: Surface Water Hydrology	---	Words 2329 - 2903
TPSL	Integer	Text for Category III: Topsoil	---	Words 2904 - 3537
VGTA	Integer	Text for Category IX: Vegetation	---	Words 3538 - 3732

Part 6: Expectation Values (see CLAIM User's Data book)

Variable Name	Type	Description	Units	Location
ANIMAL	Integer	Expectation values for Category IX: Animals	---	Words 3733 - 3810
CLIMAT	Integer	Expectation values for Category II: Climatology	---	Words 3811 - 3858

Variable Name	Type	Description	Units	Location
GENDES	Integer	Expectation values for Category I: General Description	---	Words 3859 - 3906
GRWHYD	Integer	Expectation values for Category VII: Ground Water Hydrology	---	Words 3907 - 4020
OVRBDN	Integer	Expectation values for Category V: Overburden	---	Words 4021 - 4188
SOCECN	Integer	Expectation values for Category X: Socio-Economics	---	Words 4189 - 4362
SUBSOI	Integer	Expectation values for Category IV: Subsoil	---	Words 4363 - 4542
SURHYD	Integer	Expectation values for Category VI: Surface Water Hydrology	---	Words 4543 - 4680
TOPSOI	Integer	Expectation values for Category III: Topsoil	---	Words 4681 - 4878
VEGETA	Integer	Expectation values for Category IX: Vegetation	---	Words 4879 - 4938

Part 7: Category Responses (see CLAIM User's Data book)

Variable Name	Type	Description	Units	Location
RANIMA	Integer	Response to Category IX: Animals	---	Words 4939 - 4941

Variable Name	Type	Description	Units	Location
RCLIMA	Integer	Response to Category II: Climatology	---	Words 4942 - 4943
RGENDE	Integer	Responses to Category I: General Description	---	Words 4944 - 4946
RGRWHY	Integer	Response to Category VII: Ground Water Hydrology	---	Words 4947 - 4951
ROVRBD	Integer	Response to Category V: Overburden	---	Words 4952 - 5021
RSOCEC	Integer	Response to Category X: Socio-Economics	---	Words 5022 - 5027
RSUBSO	Integer	Response to Category IV: Subsoil	---	Words 5028 - 5035
RSURHY	Integer	Response to Category VI: Surface Water Hydrology	---	Words 5036 - 5041
RTOPSO	Integer	Response to Category III: Topsoil	---	Words 5042 - 5050
RVEGET	Integer	Response to Category IX: Vegetation	---	Words 5051 - 5052

Part 8: FEASI, TECON, OPUSE Subsystem Parameters

Variable Name	Type	Description	Units	Location
CAAHM	Real	Cost/Acre to apply hay mulch	$/Acre	Words 5053 - 5054

Variable Name	Type	Description	Units	Location
CABAH	Real	Cost/Acre to buy/apply herbicide	$/Acre	Words 5055 - 5056
CABFN	Real	Cost/Acre to buy fertilizer: Nitrogen	$/Acre	Words 5057 - 5062
CABFP	Real	Cost/Acre to buy fertilizer: Phosphate	$/Acre	Words 5063 - 5068
CABHM	Real	Cost/Acre to buy hay mulch	$/Acre	Words 5069 - 5070
CABS	Real	Cost/Acre to buy seed	$/Acre	Words 5071 - 5074
CAC	Real	Cost/Acre to chain	$/Acre	Words 5075 - 5076
CACP	Real	Cost/Acre to Chisel Plow	$/Acre	Words 5077 - 5078
CADF	Real	Cost/Acre to Drill Fertilizer	$/Acre	Words 5079 - 5080
CADH	Real	Cost/Acre to Disc and Harrow	$/Acre	Words 5081 - 5082
CADS	Real	Cost/Acre to Drill Seed	$/Acre	Words 5083 - 5084
CAEAF	Real	Cost/Acre to erect animal fencing	$/Acre	Words 5085 - 5086
CAHSAF	Real	Cost/Acre to hydromulch seed and fertilizer	$/Acre	Words 5087 - 5088

Variable Name	Type	Description	Units	Location
CAHSTS	Real	Cost/Acre to hand plant shrub and tree seedlings	$/Acre	Words 5089 - 5090
CAIP	Real	Cost/Acre to irrigate plantings	$/Acre	Words 5091 - 5092
CAR3FC	Real	Cost/Acre to rip three foot centers	$/Acre	Words 5093 - 5094
CASF	Real	Cost/Acre to snow fence	$/Acre	Words 5095 - 5096
CASNC	Real	Cost/Acre to seed nurse crop	$/Acre	Words 5097 - 5098
CSTES	Real	Cost to excavate spoil	cents/ cu. yd.	Words 5099 - 5100
CSTRM	Real	Cost to remove topsoil	Cents/ cu. yd.	Words 5101 - 5102
CSTRP	Real	Cost to respread topsoil	Cents/ cu. yd.	Words 5103 - 5104
FAVG	Real	Feasibility Averages	---	Words 5105 - 5114
PFSTSP	Real	Percentage for stabilization of topsoil storage pile	Percent	Words 5115 - 5116
PFAC	Real	Percentage for administration costs	Percent	Words 5117 - 5118

Variable Name	Type	Description	Units	Location
RCLTEC	Integer	Text for reclamation techniques	---	Words 5119 - 6104
TCAR	Real	Total cost/acre to reclaim	$/Acre	Words 6105 - 6114
THICK	Real	Thickness of litho-logic units	Feet	Words 6115 - 6134
THKTS	Real	Thickness of topsoil	Inches	Words 6135 - 6136
TTL	Integer	Title	---	Words 6137 - 6176

Appendix B
Label Common Declaration:

1. ALTRN

This declares the integer array ALTN.
ALTN contains the text for the land use option:

```
ALTN(1, 1-4) = "Cropland"
ALTN(2, 1-4) = "Nat. Veg."
ALTN(3, 1-4) = "Wildlife"
ALTN(4, 1-4) = "Nat. Rec."
ALTN(5, 1-4) = "High Use"
ALTN(6, 1-4) = "Other"
```

2. CTIL

This declares the integer array ICAT.
ICAT contains the text for the categories:

```
ICAT(1, 1-12) = "General Description"
ICAT(2, 1-12) = "Climatology"
ICAT(3, 1-12) = "Topsoil"
ICAT(4, 1-12) = "Subsoil"
ICAT(5, 1-12) = "Overburden"
ICAT(6, 1-12) = "Surface Water Hydrology"
ICAT(7, 1-12) = "Ground Water Hydrology"
ICAT(8, 1-12) = "Vegetation"
ICAT(9, 1-12) = "Animals"
ICAT(10, 1-12) = "Socio-Economics"
```

3. TABLE

This declares the table values and in the dragline relationship routines:

```
TBLV = Volumes graded
TBLT = Total costs of grading
TBLA = Total areas graded
TBLS = final slope increments
JCOUNT = number of items in the table
TSMIN = minimum of the Final Slopes
KODE = indicator switch (1 = table, 2 = no table)
TSMAX = maximum of Final Slopes
TVMIN = minimum of the volumes
TVMAX = maximum of the volumes
TAMIN = minimum of the areas
TAMAX = maximum of the areas
TTMIN = minimum of the total costs
TTMAX = maximum of the total costs
```

Appendix C
Programs Using Swap Control

Subroutine	Control Program
GETID	GETIX
ISNEV	ISNEX
GDE	GDEX
GLDE	DLGEX
DLRLE	DLRLX
DLRSL	DLRSX
DLDCS	DLDCX
DLST	DLSTX
TSGE	TSGEX
TSIHB	TSIHX
TSIFG	TSIFX
TSXBA	TSXBX
TSXFS	TSXFX
TSIFN	TSIFØ
TSSCI	TSSCX
TSSCF	TSSCØ
TSST	TSSTX
TSXST	TSXSX
TSSTP	TSSTØ
EIAD	ESADX
EIFD	EIFDX
CLIMA	CLIMX
TOPSO	TOPSX
SUBSO	SUBSX
OVRBD	OVRBX
SURHY	SURHX
GRWHY	GRWHX
VEGET	VEGEX
ANIMA	ANIMX
SOCEC	SOCEX
DCDSI	DCDSX
DCDSZ	DCDCØ
DCEV	DCEVX
SRCD	SRCDX
FEASI	FEASX
TECON	TECOX
OPUSE	OPUSX

Dummy subroutines are contained in the routines:

CLAIS for CLAIM
GDES for GDE
DLGES for DLGE
TSGES for TSGE
TSIFS for TSIFG
TSXSS for TSXST
EIFDS for EIFD

Appendix D
System routines used by CLAIM

The following table lists those system routines used by the CLAIM system, along with a general description of their use. For a more complete description or these routines, the user is referred to SEAMPLAN (Mooney et. al. 1979) and the RTE manual (Anonymous 1978).

System Routine	Use	Reference
EXEC	Called by Program CLAIM to allocate tracks for the common block. Called by subroutive SWAPC to write/read from the allocated tracks, and to swap control to the a son.	Anon. (1978)
RMPAR	Called by the "Father" to retrieve the parameters describing the location of the common block on the tracks. Also called by program CLAIM to get the logical unit number of the user's terminal.	Anon. 1978
GETLU	Initializes the logical unit for plotter.	Mooney 1979
SETPM	Sets plotter size	Mooney 1979
IDSEG	Called by subroutine SWAPC to "RP" or "OF" the ID segment (See (1) for the RTE cammands "RP"; and "OF")	Mooney 1979
OTSPL	Called by DCEV, DCDS1, and DCDS2 to spool output to the line printer	Mooney 1979
PLOT-10/TCS	The PLOT-10 terminal control system subroutines are used for graphics commands. The HP system only allows a 5 character subroutine name, so the subroutine names described in the PLOT-10 user's manual have been shortened where necessary.	Mooney 1979
SPOLU	This routine is used to access data in disc files.	Mooney 1979